Atkinson

*THE APPLICATION OF SCIENCE TO THE PRODUCTION AND CONSUMPTION OF FOOD.*

AN

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# EDWARD ATKINSON.

VICE-PRESIDENT,

CHAIRMAN, SECTION I,

ECONOMIC SCIENCE AND STATISTICS,

OF THE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

AT THE

ANN ARBOR MEETING,

AUGUST, 1885.



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LADIES AND GENTLEMEN:—I have been called to preside over your Section at the present meeting without having had any previous experience in the conduct of the work; I have, therefore, been somewhat at a loss as to what might be my duties or my privileges; but as soon as I began to consider the object of the Association the way became very plain.

If I rightly comprehend this purpose it is not to popularize science by lowering its standard, but it is to bring the progress of science and art in their application to human welfare, prominently before the public and to bring together all who have even a moderate knowledge of the sciences; while at the same time rendering it easier for all who are engaged in the higher branches of scientific research to coöperate together,— to confer with each other,— and to aid each other in those preliminary investigations which must often take many, many years before their results can be applied to the material welfare of humanity.

Give all the credit that we may or which is due to those who engage in the pursuit of knowledge or in the evolution of science for its own sake; yet, in one way or another, their work may finally rest, for its justification, upon its influence on the material welfare of the race. We are all members one of another, and the word which the Philistine may whisper to the Children of Light might be something like this: "Our Section I may be only the bread and butter section; we may deal only with the prosaic subject of providing food, shelter and clothing; we may be only trying to find out how to save a few dollars' worth more or less to the

community, but what would become of all the rest of you without us?" Like other men, our scientific brethren must be provided for and sustained. Would that they were more fully sustained, and that their modicum of food, fuel, shelter and clothing could be supplied to them in greater measure and on less arduous and penurious conditions than those under which they are sometimes forced to work.

Perhaps we may open the way for more adequate provision for the higher branches of scientific research, if we connect it directly with the subjects which belong especially to our own section. Can we not prove, so that he who runs may read, that the only safety is in science and that the so-called "practical man" who distrusts its teachings is the most unpractical of mere theorists? Is he not often the man who thinks he knows everything from his own insufficient observations and yet is utterly ignorant even of the simplest principles of his own art?

To this end the direction of this address will be devoted mainly to opening the subject of the future applications of science to the production and use of food.

What is the present daily ration of the working men and women who constitute the vast majority of the people of this and other lands?

What does it cost them in money or in labor?

What might be the daily ration if the science of nutrition could be made a part of the common knowledge?

How much could its cost be reduced, and its nutritious properties increased?

In preparation for this meeting I have endeavored to bring into clear view the vast changes, both social and scientific, which have rendered the production and distribution of all commodities, and especially of food, so much easier and more equitable during the present generation than ever before. I have also endeavored to forecast, as far as we may, that further progress which may be immediately before us, perhaps to be completed before the end of the present century in some special directions, such as in the division of the electric current, or in securing a supply of nitrogen at low cost in agriculture.

I shall endeavor to demonstrate to you that in the generation which will have passed between the end of our civil war and the beginning of the next century, greater progress will have been

made in the way of material welfare, that is to say, in the production and more equal distribution of wealth, than in any preceding period of the same term, and perhaps more than in any preceding century since history began to be written.

The true beginning of the economic history of this country may hereafter be dated from the year 1865; that is to say, from the end of the active war in which the passive war of slavery culminated and by which it destroyed itself.

I present this great social change as of the first importance, in its influence upon the economic history, not only of this country, but of the world. To the English-speaking people seems to have been given the power of extending their influence and their institutions over every part of the globe. It has been clearly pointed out by Prof. Seeley, that while greater Germany, greater Portugal, greater France and greater Spain have almost ceased to exist, greater England continues to expand. Already the English speaking people of the United States outnumber those of Great Britain and all her colonies. What is the force which enables the English State to exist, to expand and to dominate all others? What is the essence of the common law of England? Is it not the spirit of individual liberty? When slavery attempted to dominate, it destroyed itself in conflict with the very principle of liberty on which this nation was founded by Washington, Jefferson, Laurens and Patrick Henry of the south as truly as by Hancock, Adams, Hamilton and Franklin of the north.

Only within the last twenty years has it been possible for any one of us to speak of our country as a land of liberty without a blush of shame. Yet so completely has this change been effected as to have enabled me to say to our southern brethren, with their hearty approval, that so absolute has been the revolution not only in their institutions but in their ideas, that it would take a greater war to reimpose the burden of slavery upon them than it did to destroy it; and I added that the time may not be far distant when the descendants of confederate soldiers will erect a monument to John Brown upon the heights of Harper's Ferry, in commemoration of the liberty which he gave to the whites of the south when he fired the first shot for the freedom of the blacks.

Coupled with this great social change have come such material changes that I think it is perfectly safe to say that "*Uncle Sam*," considered as a concrete individual can do at least a third more

work in the same number of hours and can produce a third more product measured by quantity in ratio to a given amount of labor than was possible for him to produce and distribute twenty or twenty-five years ago.

My chief purpose in this address is, first, to pass in review these other changes, aside from the destruction of slavery, which have been brought about by the advancement of science, by means of which the necessary struggle for life has been so greatly lessened and the abundance, especially of food, has been so vastly increased. I shall then endeavor to forecast the future in such a way as will at least give a dim perception of what the next century may have in store for our children, if the inventions or discoveries, which now seem to be on the very edge of being perfected, shall be presently completed.

In the course of less than this single generation which will have passed between the date when peace had become established and the unity of this nation had been assured by the removal of the only cause of disruption, mankind, as a whole, will also have gained greater power over the forces of nature and will have reduced the effort necessary to secure a comfortable subsistence in greater measure than in any other similar period in the recorded history of the world: not even excepting the generation in which the smelting of iron with mineral coal was first discovered, in which period the steam engine was also invented; or that in which the modern textile factory, the railway and the locomotive engine were first put to use; or that in which the steamship and the telegraph wire first crossed the ocean.

Perhaps the only period which can be compared with the present in the importance of the new forces placed at the use of man, would be that in which gunpowder was invented. This invention was of supreme importance in economic history. It finally completed the change in the method of the distribution of wealth from status to contract. It affected society more profoundly than any other invention ever made, because it rendered the weak man equal to the strong man. It destroyed the power of the man clad in armor to secure wealth without work. It made modern mining possible, rendering metals abundant. It equalized the conditions of men without regard to superior strength. It substituted brain for muscle; and it finally turned the scale between despotism and freedom, by rendering individual liberty possible.

It is I think commonly assumed that the invention of the steam engine, the spinning frame and the power loom, which came nearly together, made greater changes in the production and distribution of wealth, perhaps in a single half-century, than ever occurred before or since; but you will observe that the force of steam was substantially limited during the first half-century of its application, to reducing the cost of labor in making textile fabrics for clothing and in working metals, but that it has only been in recent years that it has exerted any great influence in respect to the production or distribution of food.

Now, important as clothing may be, it is relatively unimportant as compared to food in the proportion of labor required for its production.

Even at the present time, all the available statistics prove that, measured in terms of money, the cost of food (including drink as one element, for whatever it is worth), is not less than three times the cost of clothing to the working people of this country and it bears even a greater proportion to the whole cost of living of the working people of Europe, probably four or five to one.

If this be so now, how much greater this disparity must have been twenty-five years since when the value of grain was exhausted by transportation over an area of one hundred and fifty miles on common highways, and when our railway service consisted only of a few disconnected lines inefficiently operated for a very limited service over a small area.

If, then, one-half the struggle for life measured in money, and more than one-half when measured by the work of the household of the prosperous mechanic, artisan, or operative; yet more than one-half, even in money, in respect to the common laborer, is the price paid for food, I think you will agree with me that the inventions and improvements of the last twenty years which have been, you will observe, mainly directed to the increased production and cheap distribution of grain and meat, have affected human welfare in even greater measure than those which ensued immediately after the invention of the steam-engine and the spinning-frame and more than any other inventions which have come into use in any single generation, or perhaps in any single century.

Limiting our present treatment to our own country, let it be observed that the one provision of our constitution which binds

these states most firmly into one nation is that which forbids any interference with free commerce among the states.

Under this provision, competition is now absolutely free over a larger area and among a greater number of people than are permitted this privilege in any other part of the world.

Suppose this provision of the constitution had not existed and that the people of the state of New York had endeavored to obstruct the purchase and use of the wheat of the far west, who would have suffered?

But although exposed to this free competition, the wheat production of New York is now almost as large as when Genesee county was the centre of the wheat production of the country, and to it has been added the great variety of profitable crops which make wheat but an insignificant factor in the whole agricultural product of the state of New York.

In making this statement, that competition is free over a larger area and among a greater number of people than anywhere else, I do not forget the existence of prohibitory liquor laws, or of laws in some of the states which restrict the liberty of adults in making contracts for the hours of their labor. The effect of such laws constitutes so slight an exception to the competition which is otherwise free, that they may be entirely ignored; neither would it be worth while to complicate the subject now under consideration by a discussion of the tariff question. It may be admitted that free competition has not existed between this and other countries, but this fact may be treated as an incident rather than as a prime factor in our progress: for the reason that owing to our great diversity of soil, climate and other conditions, substantially every branch of mechanical and manufacturing industry either had been established or would have been so, sooner or later, whatever our fiscal policy might have been. It is seldom observed that there are a natural diversity and balance of occupations in every civilized country, and the effect of tariff is rather to change the direction of a small part of the work done, than to alter materially the relative proportions. This has been especially true in this country where even the productions of iron and steel and the manufacture of woollen and flax antedated the birth of the nation itself and could not be suppressed even by all the power which the mother country exerted over the colonies.

In this area and among the people of this country, may be found as great diversities of climate, soil, condition, method of taxation (and even in systems of law, bearing Louisiana in mind) as are to be found existing between the people of different states or nations, hence a necessary diversity of occupations.

If we may judge institutions and customs by their fruits, this dominating spirit of liberty, of individualism and of free competition, has been most fully justified in its results. I may here refer to a subject which I have elsewhere treated at some length, to wit: that in this principle of competition we have the most effective mode of coöperation among men, and that its ultimate beneficent result will be to remove all poverty which is not due to mental or physical incapacity. Time does not suffice to develop this branch of the subject in this address.

Imperfect, inadequate and insufficient as our system of common education may be, and subject as we have been to the incoming in enormous numbers of the illiterate or uninstructed of other lands, yet the people of these states possess on the whole that kind of education in greatest measure, whether attained in the schools or outside of them, which enables them to grasp the opportunities placed at their disposal by the advancement of science and by the progress of invention, and to apply them in the most productive way.

We may be very much dissatisfied with existing conditions. Life is altogether too narrow to the great mass of our people. Discontent, as well as necessity, is the mother of invention and the incentive to progress, but we may yet claim that nowhere else can such conditions of material prosperity be found as are even now to be found in this country, however dissatisfied and wholesomely discontented we may be.

Nowhere else are the products of labor and of capital so adequate and so ample.

Nowhere else are wages and profits so high.

Nowhere else is the cost of all production when measured in terms of labor so low.

Nowhere else are high wages, either in money or what money will buy, so sure to be the consequent result and reward of a low cost of labor.

Nowhere else, high as our taxes are, is so much general benefit gained from the expenditure of the taxes.

Nowhere else is so small a proportion of the public income wasted for destructive purposes, in the support of standing armies and navies, and in the passive war which is now reducing Europe to pauperism in almost every part of that continent.

As I have said, even our civil war itself, and the heavy taxes which have been imposed since it ended, have but little retarded our material progress.

There was not a single year during the war itself, in which the production of the northern states did not increase in quantity and in value, in a measure greater than the expenditure for the war in that year, and could any equitable system of taxation have been invented and applied quickly enough, the whole cost of the war might have been defrayed during its very progress; and yet the free states and territories would have come out with a larger capital, and a greater power and measure of production at the end than at the beginning, while the south would have been redeemed from poverty by the destruction of its fictitious wealth.

Not only may these propositions be maintained but it has lately fallen to me to prove (see Distribution of Products, G. P. Putnam & Sons) what Mr. Robert Giffin has also lately proved to have been the course of events in Europe: namely, that during the last fifty years, in the latter part of which the greatest relative progress has been made in the application of science to the useful arts, those whom we miscall the poor because they may as yet have accumulated no substantial amount of property, have yet annually obtained an increasing share of an increasing product, while the proportion of the annual product secured by the rich as a separate class, has steadily become a decreasing proportion. Yet such has been the rapid increase of product year by year that while the poor have thus become more prosperous the rich have become no poorer and are more numerous. There have been temporary fluctuations but in each decade such has been the conclusion; even the present period of alleged depression is one in which the greatest relative progress is being made and when the adjustment is completed to the new conditions arising from the more recent applications of science which I shall presently consider, I venture to predict that it will become evident to the most superficial observer that such is the fact.

These are perhaps startling propositions and they may be questioned.

Let us glance at the list of almost new forces which were perfected, extended or applied during the war, or which have been put to use since the war ended, both in this country and elsewhere.

Afterward we will consider the newly available areas of productive land which have been put to use in this and other countries during the same period, from which we now derive a part of our own abundance in exchange for the excess of our domestic products.

But before we consider these new forces, a few words need to be given to certain changes which occurred in the decade immediately preceding the war.

In ten years prior to 1860–61 California and Australia had suddenly rendered up their great stores of the precious metals, as if in anticipation of the needs of the great commerce which other discoveries and new inventions were so soon to bring into existence.

It is often, but I think mistakenly, supposed that there is a productive force or influence in gold and silver themselves, and that a great addition to the money metals of the world constitutes a great addition to the productive powers of the world. I question this view; these metals are but instruments of distribution.

Had not the vast additions of the precious metals been accompanied or immediately followed by the application of these other forces, which I shall presently name, and which made greater production and wider exchange of products possible, the only effect of the addition of such a vast fund to the money metal of the world would have been a great advance in the prices of commodities; and during such a period the rich would have become richer, while the poor would have become poorer; for the reason that any inflation of the currency, whether on a paper basis, or on a specie basis which is effected suddenly, raises prices much faster than wages follow. Witness the effect of the great mass of gold which was suddenly placed at the disposal of Germany by the payment of the French indemnity. It may be questioned whether the disasters which ensued from this sudden accretion of wealth in Germany were not greater than the burden imposed upon France. It precipitated the one country into disastrous speculation, while the other went quietly to work to replace the devastation of war.

It is only the stimulus that rising prices have in making

employment continuous, which renders them any benefit to those who work for wages.

The exchange of this vast increase of our products, which immediately followed the addition of our stock of money metal after 1850–60, might have been hampered and crippled for want of instruments of exchange, except for the discovery of gold; but to impute abundance of other products to this discovery, as a cause of the increase, might be like imputing the abundance of petroleum with which the world is now lighted, to the scarcity of whales. Many other analogies could be found.

In connection with the production of the precious metals the wonderful inventions in hydraulic mining may be named, which belong to the period now under consideration, in the application of which it has become profitable to wash a ton of gravel for ten cents' worth of gold.

Prior to 1865 the railway mileage of this country was less than 34,000, consisting in great measure of detached lines, many of them serving for merely local purposes. Even the consolidation of a through line from New York to Chicago did not take place until 1869. Now our railway mileage is over one hundred and twenty-five thousand miles, consolidated in great systems and worked with an efficiency and economy unknown in any other country. One-half of the traffic over these railways consists of food for man or beast. The grain crop of 1865 measured 1,127,499,187 bushels; of 1884, 2,981,920,332. That of 1885 will probably exceed 3,000,000,000, over 50 bushels per capita.

What would have become of this food had it been raised while the limit of transportation by wagon was limited within an area of one hundred and fifty miles? Would it not have rotted upon the field had it been produced?

It was the Bessemer method of making steel which rendered this transportation of food possible over the longest distance at the lowest cost.

The man who now gives up one holiday in each year, and devotes it to earning wages, removes the obstruction of a thousand miles of distance in obtaining his year's supply of food. One holiday in the year devoted to work puts the mechanic of Massachusetts next door to the prairie of the west.

New inventions in the manufacture of steel even now in progress of application in this and other countries, may, presently,

do away with the necessity of moving the ores of iron over long distances by rendering the presence of what have been impurities in the ore of little consequence; thereby bringing into immediate use vast deposits of iron ore in the very heart of our own country which have until now been of little use and almost of no value. And when we adopt these processes we may then convert iron ore into food for man and beast, as they now do in Germany, where the waste of the "*basic*" process of making steel is now treated for the recovery of phosphate of lime which is left in the slag, to be converted into a fertilizer.

Is it not a startling thought that modern science has converted iron stone into food?

In the period under consideration the screw propeller has finally displaced the paddle-wheel in all ocean traffic. At the same time the compound steam engine has been perfected; the end of both being that the fuel required has been vastly reduced, and where it required over 200 tons per day of coal to cross the Atlantic twenty years since, a much more capacious steamer is now driven across by the use of 35 tons. But this statement is far from showing the full change; the important matter is the ratio of the fuel to the weight moved; every pound of coal now carries thirty-two times as much cargo across the Atlantic as could be carried thereby in the earlier days of ocean navigation. The steamer "Persia," in 1850, consumed 14,500 lbs. of coal to each ton of cargo, while even the racer "Arizona," in 1882, consumed only 450 lbs. per ton of cargo. In the freight steamers, assuming paper to have the same calorific value as coal, the combustion of an ordinary letter, such as is carried by mail for a two-cent stamp, would move a ton of cargo and its share of the vessel two miles. A lump of coal which can be mailed anywhere in the Postal Union for one cent would do the same work. Thus has room been made for cargoes of provisions or other merchandise, now carried at low cost more than half way round the world, to feed and clothe the people of the most distant lands.

The Suez Canal has restored commerce to its old lines, but by more speedy and cheaper methods. The general adoption of the telegraph renders distribution quick and equal, and these two forces have done away with the necessity of accumulating and storing great stocks of merchandise at heavy cost and in other ways have vastly reduced the cost of distribution.

Agricultural machinery has been perfected in this same period to the end that the equivalent of one man's labor for one year, in the direction of this machinery, is wheat enough to give a thousand people all the bread they customarily use during the same twelve months, while corresponding inventions, too numerous even to mention separately, have reduced the labor cost of producing corn, oats, and of making hay in almost equal measure. One man's work for one day will pay for moving a year's supply of grain and meat a thousand miles and one man's work for one year on the far away plains of Dakota will yield wheat for a thousand people for the same time.

Not only have our own prairies and those of Canada been brought to the use of man by these inventions and the application of these new forces, but the vast plains of Australia, New Zealand and the middle sections of South America, upon the Paraguay and Parana rivers, now send their grain or their dry or frozen meat to the hungry men of Europe, and yield up the abundance of their wool to all who are wise enough not to obstruct its use. Except for the railway and steamship their products would have been almost without value.

Within this period the whole process of canning meat, fish, fruit and vegetables has been developed, the refrigerator car and steamship compartment have been constructed, cold storage houses and ripening houses have been invented :—in the latter the banana, one of the cheapest and most abundant of the tropical products, which was first introduced into the temperate zone as a luxury, may be ripened in such abundance and at so low a cost that it may yet become an important article of food, being very rich in nitrogen.

The oil wells of this country and Russia have given light to those who could never before extend their day's work beyond what the sunshine permitted. The invention of the pipe lines for distribution has enabled that product to be distributed. In this connection may be mentioned the extraction of colors ; or, as my friend Dr. T. Sterry Hunt stated it, when I asked him to add to my list any other suggestion of important inventions, "the creation of new coloring materials from hydro-carbons, chiefly from the refuse of coal distillation, which have already made a revolution in dyeing and printing. Yet more important, perhaps, as suggestive of what may follow, we may name the artificial production of

alizarine (the red of madder) and of indigo both of which substances are now manufactured on a large scale, while the madder culture has been almost abandoned on account of the greater cheapness and the advantage in the use of the artificial substitute. This abandonment of madder culture is not a loss, but a gain: because it frees large areas of land in some parts of Europe which are needed for the cultivation of grain."

Not least among the advantages which have ensued from the distillation of petroleum, has been the substitution of the lubricants made therefrom in place of animal or vegetable oils; the latter, being subject to rapid oxidation commonly called spontaneous combustion, were constant sources of danger in the factories where they were once used, while the mineral lubricants now in use, are absolutely free from this danger.

When we bear in mind this fact, that important products like indigo and alizarine have been derived from these mineral sources, is it visionary to suggest that a time may come when the *hydrocarbons* may be converted into the *carbo-hydrates* of which we hear so much in the chemistry of food? After we have converted iron-stone into food by way of the laboratory of the soil, and since we have generated colors and perfumes from coal tar, may we ever expect to convert the hydro-carbon of petroleum into the carbo-hydrate of the physiologist in the laboratory of the chemist? Another revolution has occurred in the production of soda by the ammonia process, replacing the old method and dispensing with the use of sulphur. We all know that the march of civilization may be measured by the demand for soda ash and other alkalies.

In connection with this may be named the processes by which all the volatile products of the coke ovens are now saved, and a vast product of oils and of ammonia is thus obtained.

In medicine the artificial product of the alkaloids such as morphine and quinine may be mentioned as among the possibilities of the near future. To these may be added the great discoveries which have been made during the last few years in the use of antiseptics, especially in connection with the preservation of fruits, wine, beer, etc.

Electricity has been put under control as yet mainly for light, but who can tell how soon the electric current will be divided or when this old but ever new force may be placed in every house-

hold, to be applied even more readily than the force generated by the combustion of coal.

Among the lesser of the new mechanical forces which have been applied during this period, we may name the substitution of the roller for the mill-stone in the preparation of flour, while the wheat elevator for the storage of grains has been perfected.

The driven well, which may hereafter make many a desert blossom like the rose.

The application of the diamond drill, worked by steam or compressed air to the boring of these wells, and also to mining.

The use of nitro-glycerine, or other high explosives in mining.

The application of steam or hydraulic power to the derrick or the crane for handling heavy weights, and for loading and unloading vessels.

The introduction of the elevator, lift or vertical railway into hotels, office buildings and warehouses, whereby the aggregate rent of land has been reduced, although the special rent of particular places may have been increased.

Not least among the developments of this period has been the great perfection to which machine tools have been brought, accompanied or rendered possible by the adoption of standard measures and gauges, to the end that the interchangeable system has been applied to almost every kind of mechanism from the locomotive engine and the sewing machine to the finest watch. The sewing machine has become the common implement of the housewife, the seamstress, the shoemaker and the sailmaker.

A woman may pass through the office of a Lynn boot and shoe factory to inspect the work who, being measured as she passes the office, will find a pair of boots perfectly fitted to her foot, finished and ready for her use as she goes out, after having looked over the five floors of the factory. The boots will have passed from machine to machine much faster than she can comprehend the process of the work even in the most superficial way.

Every one of you will add something to this list, each important in its place. And to these absolutely new applications of science may be added improvements in the construction of old machines previously invented, especially in the textile arts, by means of which the product has been increased and the requisite number of laborers has been reduced in greater measure than in any pre-

vious period since the substitution of automatic machinery for the spinning wheel and the hand loom.

In the cutting and preparation of timber and its conversion into boards, I have been told that a few simple inventions have rendered the work of one man as effective as that of sixteen men twenty years ago. A little stream of cold water distributed from the hollow axle of the circular saw, to keep the saw cool, has rendered it possible to substitute six foot circular saws and a steam feed for four foot saws or less, fed slowly by hand. The planing machine invented a little earlier has come into practical use together with innumerable other inventions in wood working.

The application of iron and steel to purposes of construction has made vast progress, of which the elevated railway in New York is a conspicuous example. The common use of structural steel may also be named and the development of the cantilever principle in bridge construction.

But iron is less useful, less safe and more costly than timber and brick, even at the present prices, for the construction of mills, works and warehouses; and in these branches of construction very great progress has been made in the combination of brick and timber. By the adoption of suitable methods the modern American factory has become one of the safest fire risks in the world, costing less for its insurance than the so-called fire-proof factory of Great Britain.

This safety from loss by fire has been accomplished, in part, by what is known as the open timber construction, free from cellular or concealed spaces, the timber being in some dangerous places protected by plastering laid on wire lathing; and in part by the adoption of the system of automatic sprinkling, whereby the fire lets on its own water, puts itself out and tells where it is at the same moment.

Another great step in the progress of the art of building factories and works consists in reducing the number of stories as nearly to one as circumstances will permit. The use of a three-inch solid deck made of timber, for a roof, making the one-story factory cool in summer, warm in winter, while such a one-story factory may be better lighted and ventilated, and is more suitable for general use than any other form.

In this connection reference may be made to some of the possibilities of the future.

The adoption of steam power and the use of coal gas for lighting have rendered a great concentration of the manufacturing and mechanical arts an absolute necessity; this concentration of the work in closely built towns and cities has of necessity been followed by a concentration of population under adverse conditions, both with respect to health, economy of rent and other matters.

Whenever the electric current can be divided economically, so that a measured amount of power or light may be sent over wires in different directions from the same source, water power may be utilized where dams can be built with the greatest economy, but which are now useless for want of proper space for the construction of factories near them.

Large steam engines working at $1\frac{4}{10}$ lbs. of coal per horse power per hour, or less, may be substituted for small steam engines requiring from four to eight lbs. Gas for heating purposes may soon be as widely distributed as it now is for illuminating.

Under such conditions, power and light being furnished in the same manner, the directions for the work given by the telephone from the city office, factories which now occupy dangerous and unsuitable positions in the fourth, fifth and sixth stories of our city warehouses, may be scattered over a wide area in the suburbs of the same cities, in well ventilated and cheaply constructed one and two story factories, surrounded by dwelling places, each with its small plot of land, where the working people can live under vastly better conditions than they can now live in the narrow courts and streets of the cities.

Less conspicuous but even more important than almost any discovery or invention yet named in their ultimate effect upon our food supply may be recited the opening of the Stassfurt potash mines in Germany, and the discovery and working of the phosphate beds of the United States and quite recently those of Canada.

In the latter, deposits, which are 80 per cent phosphate of lime, have been found in almost inexhaustible quantity, and under such conditions that they will be very cheaply furnished to all our western and northern states and territories.

Mention may also be made of the mines of very pure salt on the Canada side of Lake Superior which may presently yield, if they do not already, the necessary supply of salt most suitable for the preservation of meat; these mines are also close to the prairies of

the West and subject to our use whenever we are wise enough to remove the obstructious which now render the import of salt more costly than it need to be.

These discoveries were prophetic. Who knows yet what may come from the alkali plains of the far west or from the volcanic region which lies between Oregon and California? None can doubt that there are mines yet to be opened in that section more precious than those of silver or gold, of which one example may be mentioned, consisting of vast deposits of sulphate of alumina lately discovered.

I may venture to add, among the most important applications of science to agriculture, the re-discovery of the system of preserving green crops in pits known as "ensilage."

There remains but one great discovery to be made to round out and complete this list which I have presented to you, and to perfect the series of the present generation.

Whoever can attract the nitrogen of the atmosphere, and combine it with the potash of Germany and the phosphates of South Carolina or Canada, will add the last element necessary to secure permanent abundance in agriculture at the least cost.

It is possible, I will even say probable, that the solution of this question may lie in the one plant, as I will presently attempt to show you, which might well be adopted on the coat of arms of this country, namely, Indian corn. Perhaps this symbol may be justified in the peaceful war which we have just waged with our foreign enemies.

Who were our enemies when we were engaged in a contest for liberty? Were they not the privileged classes of Europe, whose main-stay has been the rent of the land possessed, but not worked by themselves?

We have attacked them with ship-loads of grain and meat. We have sustained the operatives of England who sacrificed even their daily bread in our cause, while we have rendered the collection of rent from land devoted to grain hereafter almost impossible in Great Britain, except it be earned by the owner himself who may put capital, brains and personal industry to the use of his own land.

Said I not rightly that greater progress has been made in the period which has elapsed since the beginning, or even since the end of our civil war, in the advancement of science and its appli-

cation to human welfare, than in any other previous generation in the history of the world?

Time will not suffice for me to more than refer to the substantial foundation and extension of technical education in the same period both in this and other countries; to the beginning of scientific methods of manual instruction; to the great development of statistical science; and to many other intellectual factors which have also marked the era of which we are treating.

But there is a reverse to this pleasant picture, and much more remains to be accomplished.

Vast progress has been made in individual wealth and in common welfare. The time necessary to be devoted to the struggle for life has been reduced; leisure has been earned and earned in such a way that it has not become license, but will become the opportunity for that moral and intellectual progress which must always be founded on material progress if they are to become general.

Great as our progress has been and huge as our abundance now appears to be, yet we cannot too often recall the fact that the average product to each person in this most prosperous country, measured in money at the point of final distribution for final consumption, does not exceed fifty to fifty-five cents worth per capita, and our whole accumulated wealth, aside from land, does not exceed two or at the utmost three years' production.

Let us not boast too much nor think that we can remit our work in the least degree, when we remember that after we have set aside only so much as is required to maintain or increase our capital, so that it shall bear a due proportion to its necessary use, and after we have provided for the support of the government by taxation, each average person must find shelter and be supplied with food and clothing, out of what forty to forty-five cents per day will buy, because such is the measure in money of all that is produced and we cannot have more than all there is. I have treated this matter at length in another place, but I ask you to recall this when you are considering the daily rations which are served at a cost, varying from fifteen to thirty cents per person and the table of economic rations which accompany this address.

When our resources are thus reduced to 40 or 45 cents per day, you are somewhat startled, but each person who is engaged in gainful occupation in this country sustains two others: at 40

cents a day the expenditure of three persons comes to $438.00 per year; at 45 cents to $492.75, which are not so startling figures, when compared to what we know to be the average earnings of working people.

What can be done for those whose income is less than forty cents a day for themselves and their children and who must spend more than one-half for food? They are counted by millions even in our fair land.

Whenever any great invention or discovery displaces common laborers whose education or development has never been of such a kind as to fit them for any other work than that to which they have been accustomed, they suffer for the time.

What can we do to aid those who have been almost crushed in the onward march of industry? When partly automatic machinery is substituted for manual labor in any given art, although the many consumers gain a greater supply at less cost and a few trained workmen obtain higher wages in guiding the machinery while doing the work at less cost than before; yet, those whose only occupation had been in this handicraft may lose even the pittance which they had gained before and they are apt to be the persons least capable of adjusting themselves to new conditions. Witness the suffering of the hand loom-weavers of England when the power loom was first used. Bad as their condition had been it became for a time yet more wretched.

It is manifestly impossible to make any special provision in advance to meet the adverse contingencies of new invention.

The only adequate remedy for the hardships which must ensue, when those who have been engaged in the common kinds of handicraft have even that resource taken from them, is to develop the general system of education in such a way that there shall be the least possible number of children brought up under conditions which would limit them to a single art, and that a very low grade of hand work.

The disadvantage which ensues from the very great subdivision of labor which has been introduced with modern scientific inventions, is, that in the conduct of this work versatility or "*gumption*," as it is commonly called, is not developed such as was the very marked characteristic of the Yankee of former times.

The country boy, who attended the common school three or six months in the year, and during the rest of the time was of neces-

sity a "Jack-at-all-trades," was thereby enabled to become master of any trade to which he might afterward choose to devote his time. Such is not the case in the present day.

A good beginning has, however, been made in the attention now given to manual instruction as well as mental, but the benefit of what we are now doing in this direction will only be realized in the future. Our problem is with the present.

Witness how suddenly changes may come which involve great hardships to those least capable of meeting them.

In the census of 1880, the fact was disclosed that out of every thousand persons who were occupied in all kinds of gainful occupation, mental, mechanical and manual, three hundred and twelve could only answer the enumerator's question with the reply that they were *common laborers*. Among these common laborers there were over eighteen hundred and fifty thousand, or more than ten per cent of all who were occupied in all the arts of life, who were engaged in common labor other than that upon farms. Where were they?

They had doubtless increased in number between 1880 and 1882 by immigration in very considerable measure and in 1882 common laborers numbered at least two millions; in that year not less than six hundred and fifty thousand persons, of whom at least six hundred thousand were common laborers, were engaged in the single work of constructing new lines of railway within the limits of the United States. This railway fever culminated in 1882 with the construction of lines numbering over 11,500 miles. In 1884 the construction was less than 4,000 miles.

Between these two dates more than four hundred thousand common laborers, or more than twenty per cent of the whole number of common laborers who were not occupied upon farms, were discharged and were compelled to find other work or to be idle Where could they go? For what other work were they fitted? A part of the more intelligent and thrifty doubtless took up land upon the lines of the railway where they had been employed, but the greater part drifted back to the cities, where they gave the appearance of being much more numerous than they really were, because they were concentrated in particular places.

When this work ceased, the demand for iron also fell off a million tons, and consequently all iron works were affected, then the rolling mills. Then the demand which had existed for the supply of

the idle common laborers, of the idle iron workers, and of mechanics who had been engaged in this art of constructing new railroads, in part ceased, and the goods and wares which they had consumed began to accumulate; presently the effect of this was felt throughout the whole body politic.

One of the penalties which we pay for the complexity of the work of modern art and manufacture, is, that when the most insignificant gear is thrown out of place, the whole machine is crippled. We are all interdependent and the calamity which falls on those who are apparently the least important classes in society has an adverse effect upon the progress of the whole, like that which a slight injury to the foot, or a pebble in the shoe of a strong man, may have on his power of locomotion.

As I have said, the true remedy can only consist in the development of versatility, of manual dexterity, and of capacity on the part of the poorest child in the community, to take advantage of the many opportunities which may be found waiting at all times for those who are capable of grasping them. We may, however, alleviate the present difficulty in some measure, by reducing the necessary cost of subsistence. Before we enter upon this part of my subject, permit me to observe that in this address, I have kept the fact in view that the political economist may only treat the physical sciences in their direct connection with material progress. In the list of the scientific inventions and applications which I have presented to you, I have made no reference to abstract science or to the higher branches of research.

May I venture to give a summary of the conclusions which we may draw from the facts which I have presented so far as this country is concerned.

With respect to the primary processes of production, the applications of science, crude as they yet are in respect to agriculture, have assured an excessive abundance in ratio to any possible increase of population during this present century. There is enough for all and to spare.

With respect to the primary processes of distribution by land and by water, the cost has been reduced to such a point that there is little margin left to work upon for further saving.

In the conversion of crude materials into finished forms ready for consumption the field for invention and improvements is still a broad one.

In wholesale traffic, there is no longer any great margin to be saved and even in the retail distribution of staple articles the smallest profits suffice.

In the distribution of perishable commodities, there is an enormous waste, and in the science of consumption almost no progress has been made. It is only within a very recent period that even the statistics have been gathered, while I believe the beginning of a true study of the chemistry of food and a true science of nutrition may be dated within the period under consideration.

I have presented to you the two aspects of the question:— on the one side, the prophecy of the future, replete with the comfort of an assured abundance; while the statistics of the past prove conclusively that those who perform the arduous work of creating this abundance are steadily but surely securing to themselves an increasing share of the increasing product, and this product will yet continue to increase as capital and labor are combined in more harmonious relations.

On the other side, the data have been given which show within what narrow limits the great masses of this most prosperous people must now exist; even though they secure to themselves for their own consumption more than ninety per cent of all that is annually produced.

The danger of our time is the constant resort to legislative remedies for evils which can only be removed by the development of the individual.

I have brought this great problem of subsistence to the unit of the individual, because we can comprehend it better when it is stated in terms of what 40 or 50 cents per day will buy for each person.

We can, perhaps, comprehend how hopeless the problem of ameliorating the condition of life would be, were it not for the advancement of science, when the fact is stated that in order to give each person of our present population five cents' worth more per day, we must produce and distribute one thousand million dollars' worth more than our present annual product. We may confirm this impression both of the minimum and maximum elements of the problem by the consideration that if we reduce our present population of over 57,000,000 to the equivalent of 50,000,000 adults, by counting two children under ten as one adult, and then assign to each of the 50,000,000, one egg every two days at the

price of one cent each, then the annual value of the product of hen's eggs would be equal to the annual product of gold and silver of all our mines.

In the presence of the facts which I have submitted to you, may we not also find evidence that the hypothetical deductions of the English political economists, who narrowed the field which Adam Smith had opened but had not exhausted, must give place to more humane inductions based upon solid historical and statistical foundations.

Were there no promise of material welfare being attained upon this earth by any possible population which can find standing room upon it, all expectation of moral and spiritual progress, would of necessity be surrendered, and the only motto of the social scientist might well be, "Let us eat and drink for to-morrow we die."

I fear that I have occupied too much time in this introductory review; we will now take up the more practical part of our work.

In the various tables which will accompany this address, and in the material which has been so kindly furnished me by Prof. W. O. Atwater of Middletown, Conn., it is made apparent that there is a wide choice in the ration of food necessary to sustain an adult man or woman in full vigor and health.

Again recalling the fact that with respect to this lowest plane of common laborers, the mere price of food constitutes sixty per cent of the cost of living, even for those who are fully and continuously occupied, it will be very obvious that if we can show them how to maintain themselves in full vigor at a cost of thirty or forty per cent of their ordinary income, we shall have done good service.

In Professor Atwater's table representing the cost of protein, it appears that we if we buy protein in a sirloin of beef at twenty-five cents per pound we pay one dollar a pound for it; whereas if we seek for protein in oat meal or in corn meal, we pay twelve to fourteen cents per pound for it.

It is also proved by these chemical investigations in respect to the elements of food, that the Scotch have by a process of natural selection, adopted in their oat meal that kind of food which gives them the right proportions of nutrient material at the very lowest cost.

The people of New England have also come to a similar conclusion by a similar process: in their baked beans and pork, and in

their fried fish-balls composed of dried cod-fish and potato, even in their brown bread, are also to be found substantially the right proportions of nutrient at a very low cost. To a Yankee it would not be a very great hardship under the pressure of adverse conditions, to be obliged to substitute baked beans, fish-balls and brown bread in a more considerable measure for roast beef, than they are accustomed to do when in a condition of prosperity.

The weekly ration of the southern negro, which he chooses in preference to any other, to wit: a peck of meal and three and one-half pounds of bacon, is also one which contains the elements of vital force at an exceedingly low cost. There are probably no working people in the world so cheaply subsisted as the southern negroes, if consideration be given to the force contained in the food. The rice of the east may cost less in money, but it is deficient in some of the nutrients which are necessary to full vigor.

There are, therefore, many ways in which temporary poverty can be alleviated, but it is not altogether desirable either to advise or to attempt to promote such changes in the diet as might, under the pressure of necessity, make a considerable saving.

The people of this country can afford a more abundant diet than that enjoyed by any other country, and they will continue to enjoy it because even periods of adversity affect a relatively small number of persons however unintelligent they may be.

The same conditions affect this question as that of taxation. I suppose no economist of repute has failed to reach the conclusion, that a system of direct taxation will lead to the greatest economy in the public expenditure; or that when the taxes are collected indirectly in such a way as not to come to the immediate knowledge of the consumers who pay them, twenty-five per cent at least will be wasted; and yet I am of opinion that the people of this country would prefer to pay about twenty-five per cent in excess of the absolute need rather than to have a direct tax imposed upon them.

And so I think that the great majority will prefer to continue their present practice in respect to the use of food as long as it is a somewhat difficult matter to learn how to combine true economy with a generous diet.

Our main attention may, therefore, be given to cheapening the cost of meat, rather than reducing the consumption thereof, and

with a few pages upon this subject of a rather visionary sort, I shall close this address.

Having presented the importance of animal products in their relation to the daily rations of the people; having also presented data giving proof that a part of the ration of animal products might well be spared if it continues to be as costly as it now is, the next question which arises is: May not the cost of animal products be greatly reduced by the adoption of more scientific methods of production? Upon this subject I may present to you certain hypotheses in which, I think I may be sustained by Professor Atwater.

Let me begin by reminding you that iron ore is now being convêrted in part into animal food in Germany, and that we may perhaps look mainly to our mines and to our atmosphere for our vegetable and animal food rather than to any other source, if other sources fail. We may treat the soil as a laboratory when the soil itself fails or begins to fail as a mine. We may restore it with mineral elements from mines in which they are found in a concentrated form.

We have throughout the eastern and most densely populated section of the United States a vast area of land which is not now considered worth cultivation. Much of it has once been cultivated and has sustained an intelligent people, but when the possibility occurred for obtaining Indian corn from far distant points, the cultivation of much of this land ceased, because it was not needed for market gardens, and it did not appear to be well adapted to pasturage.

In the section of Massachusetts where I pass my summers, old fields are being covered with scrub oak, and old dwelling places are falling into decay, where by means of intelligent cultivation sixty bushels of shelled corn to the acre can be made, and it is only a question of cost whether or not such a crop shall be made. This cost again depends upon the price at which the land can be fertilized.

Now the chemists assure me that this soil contains iron, magnesia and chlorine in ample measure; that it can be furnished with potash at a very low cost from many sources, especially from the inexhaustible mines in Stassfurt, Germany; that it can be furnished with the phosphate of lime at very low cost from the phos-

phate deposits of South Carolina and of Ottawa, to which latter source reference has already been made. Along the whole New England coast are also scattered the fertilizer works which draw their supplies mainly from the sea.

But it has been assumed that unless some kind of a fertilizer could be added to these substances containing nitrogen in large quantities, the effort to raise corn upon this land would fail; yet now comes Professor Atwater who tells us that so far as his experiments and his coöperative work yet prove anything, it may be proved that the Indian corn plant is analogous to clover, to the southern cow-pea and to a few other plants, in being capable of deriving its nitrogen, somehow or other, from the nitrogen of the atmosphere or from some natural source, and that it needs no expensive nitrogenous fertilizer to be applied to the soil, provided the other elements already named are there. But while the corn has done so well with the phosphates and potash salts, it has given still larger and more satisfactory results where these and farm manures were used together. In the plan herein proposed, stable manure would be furnished in great abundance. Professor Atwater's statement is as follows:—

"The important fact is, that the corn plant has in these trials shown itself capable of bringing fair yields with small amounts of the less costly mineral fertilizers, even in the worn-out soils of the eastern states. With this help it has gathered its nitrogen from natural sources, and holds it readily to be fed out on the farm and returned in the form of manure for other crops. In other words, the experiments, thus far, imply that the corn has, some how or other, the power to gather a great deal of nitrogen from the soil or air, or both; that in this respect it comes nearer to the legumes than the cereals; that, in short, corn may be classed with the 'renovating' crops. If this is really so, and this can be settled only by continued experimenting, then our great cereal, instead of being simply a consumer of the fertility of our soils, may be used as an agent for their restoration."

If this is so, it is difficult to conceive of the importance of these facts.

As I have before said, life is but a conversion of forces, and this proposition may be sustained with regard to animal life, as well as with regard to human life.

How, then, shall we convert the forces of our mines and of the soil and air into animal food for the use of man, by working over this deserted soil of Massachusetts into a beef factory?

The way is very plain and simple—*if*. (I call you to witness that I italicize the *if*.) Witness Farrish Furman of Georgia, after carefully studying the chemical elements of the cotton plant, invented a fertilizer, at very low cost, by which he brought waste and deserted cotton land, from $\frac{1}{8}$ of a bale to $2\frac{1}{2}$ bales to the acre. In so doing he made use of the Stassfurt potash and the phosphate rocks of South Carolina. By way of his laboratory, consisting of wasted soil which had long since ceased to be a mine yielding cotton, he converted the two minerals named into cotton seed. We may buy the meal of this cotton seed, bring it to Massachusetts, there feed it and thus convert the same minerals into fertilizing elements, in the soil laboratory of Bristol or Plymouth counties.

Here we have not only the phosphate and the potash, but also a food for beasts very rich in protein, yielding the most valuable manure by the use of which we may enable our laboratory to grow Indian corn at the rate of 20 to 25 and some claim even 30 tons of forage to the acre.

Suppose we put this forage into pits and feed it at the rate of two steers to an acre, adding each year the ration of cotton seed meal to the sixty pounds of ensilage daily required by a steer. We may also soon find some other very nitrogenous plant capable of being grown in the north, which like the southern "cow-pea" will produce a very heavy crop of forage on very poor soil. Cow-pea vines, being mixed with Indian corn in ensilage pits, appear to yield the necessary proportion of protein, so that, in North Carolina, working mules are now sustained upon this mixed ration of pitted fodder in as good condition as when previously fed on northern hay.

What may be the result of our conversion?

I am assured that if we slaughter the steer, removing all the salable products, the hide, the meat, the bone and the hoof, we should yet remove less phosphate of lime and less potash than we had fed through the steer to the soil. Our Indian corn might somehow have entrapped the nitrogen of the atmosphere, and with the fertilizing elements of the cotton seed, would again have enriched the soil; our soil laboratory would thus grow more productive every year in ratio to the number of animals which we fed upon it, per-

haps until we fed possibly three steers to an acre. This has never been done within my knowledge, but I do not believe it is beyond the power of science to make such a crop upon a fair acre of land in a good season, as to yield sufficient forage to carry three steers to an acre if not for a full year, then for at least eight months in a year, and during the remainder of a year they could as well as not be turned out to the wild land in the neighborhood for pasturage. There is room enough in New England on land now going to waste to raise all the beef we can eat, and more, if such methods are feasible.

Without giving any especial attention to the matter I have myself been keeping two cows on the crop of a single acre for nearly a year, year by year since 1880, but I am rather ashamed to say that I cannot give the measure of meal or middlings. I have only proved to my own satisfaction that it is easily possible to raise as much corn fodder on an acre as two cows require for one year.

What would be the cost of beef in money? Would it not be the price of the cotton seed meal and the price of the labor? to which may be added, if any one chooses, a slight additional sum for the interest on very low priced land. I do not put interest on the capital invested into the cost of the product, because that is what the capitalist would work for; that would be his profit.

Again, if deserted land can be used in this way in the eastern part of the country, what would be the method of use?

I have referred to the land as a laboratory and to the establishment as a beef factory, and I did this with a purpose.

A small area of land can be kept under the intelligent supervision of one man (either the owner or his superintendent who may himself do no part of the actual work); then the land worked as a laboratory would be like the factory in its administration.

Furthermore, every part of the planting, cultivating, harvesting and feeding can be done by the piece, paid for by the measure, and supervised with as much accuracy as the working of the cotton factory can be supervised by an agent.

The subdivision of labor can be made in the same way; each workman in the beef factory, having his work assigned to him by measure, can be paid by the piece or job, precisely as the work of the cotton factory is subdivided. The end of such a method is the largest product at the least cost.

If the hypothesis, which is not yet absolutely proven, but in favor of which the array of facts is so strong as to leave Professor Atwater in but little doubt about it, be hereafter sustained that Indian corn has the power of gathering its nitrogen from natural sources, then it may be safely affirmed that a three-year old steer can be produced upon the waste land of New England at this time at less cost than the same steer can be produced from Texas by way of the western plains to the Brighton abattoir on the basis of the present charge for Texas cattle on their native plains.

Here, then, we may be able to reduce the cost of meat if the alternative of using less meat is not acceptable.

But, even if this solution may not prove to be the true and final one, may we not expect to displace the semi-barbarous or wild system of raising steers on our far distant plains—moving them in cruel cattle cars at heavy cost and thus providing meat which is very liable to be unwholesome — by substituting methods more consistent with science? When we can do so we may be able to advise our young men in New England to *stay east* rather than to *go west*, and thus maintain a better and safer balance in our population, of which in Massachusetts more than one-fourth part is now foreign born.

If these points are well taken; if it is possible to treat the soil as a laboratory without very much regard to its original properties, or, at least, without so much regard to the original properties as is commonly given, a great change must be made in the postulates of economic science.

When the intensive system of farming is adopted, tending to a greater concentration of the population engaged in agriculture, which change may be accompanied, as I have endeavored to show, by a wider diffusion of the population now too much concentrated in cities, the whole balance of the population will be changed; both the agricultural and the manufacturing population will be brought nearer together, and all will be brought under vastly better conditions of society than either class can now enjoy. Furthermore, several of the *a priori* concepts of the English economists must yield.

The law of diminishing returns from land can neither be sustained historically, theoretically nor practically.

The so-called law of population, that population tends to increase faster than the means of subsistence, has no foundation

historically, practically nor theoretically if the propositions which are presented in this address have any validity.

The Ricardian theory of rent will have no basis whatever.

What may be the future of humanity under these conditions no man can tell.

What may be the influence of this country upon the rest of the world no man can foresee.

In order that you may, in some very dim manner, foreshadow this influence, I beg to submit to you a few statements in figures and in black lines which I have made use of in another publication.

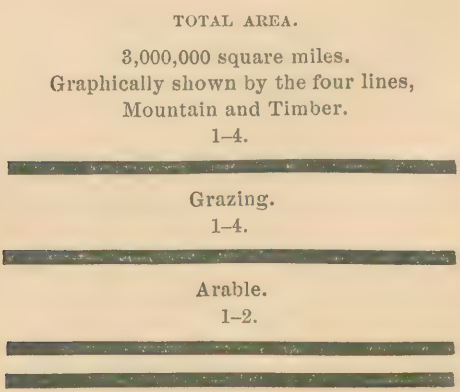
I present to you lines indicating the total area of the United States accompanied by others which show the little fraction of our soil, which has yet been devoted to the production of grain and cotton. Even this little fraction is double what would be required under an intelligent and intensive system of agriculture.

To these lines, showing what has been done, I have added other lines, showing what may be done in the production of wool, of meat and of dairy products, and these again are measured upon an assigned product to each acre of only one-half that which has been actually accomplished in certain places.

In this table, I have dealt in a rough and ready way, with the acres now occupied or which might serve for all our great crops.

The area of the United States, omitting Alaska, is a trifle less than 3,000,000 square miles.

In a broad and general way we may assume that one-half this area is good arable land, one quarter good pasture land, and one quarter forest, mountain, and mining territory.



INDIAN CORN FIELD.

112,500 square miles.

At 25 bushels to an acre this area produces 1,800,000,000 bushels. This corn is largely converted into pork at the rate of 5 lbs. of corn to one pound of pork. Assuming one thousand million bushels thus converted, and the rest used for human or cattle food, the product of pork would be equal to 18,500,000 casks or its equivalent in bacon; which would give nearly one cask of pork of 300 lbs. to each head of a group of three persons per year, or 100 lbs. per capita.

WHEAT FIELD.

60,000 square miles.

At 13 bushels per acre this little area yields a little over 500,000,000 bushels. Setting aside an ample portion for seed this quantity would give over 80,000,000 persons one barrel of flour per year.

COTTON FIELD.

20,000 square miles.



At the wretched average of only half a bale to an acre this little patch yields 6,400,000 bales in a year.

WOOL.

What the actual area of sheep pasturage is no man can tell, because the area of land absolutely free to glaziers and ranchers is so large that no question of area has arisen until within a very short time; but the end of this wasteful and archaic method can be foreseen. When the cur-dog shall have been muzzled, or when dogs shall have been declared *ferœ naturæ*, it will be easily possible to sustain four sheep to an acre over wide areas of unoccupied land in the east and south as well as in the far west; this would require a sheepfold of

40,000 sq.miles,



sustaining 102,400,000 sheep, which at only 4 lbs. each would yield as much wool as we now consume of all kinds, both domestic and foreign.

DAIRY FARMS AND HEN YARDS.

In 1880 the number of milch cows was estimated at 12,500,000, and the product of eggs was computed at 500,000,000 dozen, val-

ued at $80,000,000. Over how wide a range of pasturage the milch cow ranged it is impossible to say, but almost within the period which has elapsed since 1880 it has been proved entirely possible to feed two cows one year on the corn-stalks saved in pits which can be raised on one acre of fairly good land, if to this green fodder be added a ration of meal made from the cotton seed which was almost all wasted until a very recent time, and is yet saved in only a very small proportion. But in order to be safe we may reverse this ratio, and assigning only one cow to two acres we may greatly increase our present ration of milk, butter and cheese, with the hens' eggs thrown in.

A Dairy Farm and Hen Yard
of 60,000 square miles,



at 1 cow to 2 acres, will sustain 19,200,000 cows. I have myself no difficulty in keeping two cows one year on the forage of one acre with a moderate feed of meal, or wheat middlings added.

BEEF.

The relative importance of meat in the subsistence of our people has been shown. A large portion of our beef is now produced by almost semi-barbarous methods on the far-distant plains; but as population increases this rude way must give place to more civilized and humane modes, and our beef must be produced near its place of consumption. Provision has been made for the cornfield, and if pitted forage is as fully justified on a broad scale as it has been in the successful experiments of many able men who have applied brains and capital to the use of land, it would be necessary to assign only a small area to beef.

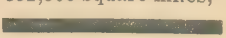
60,000 square miles,



at 500 lbs. of meat to an acre, would yield nearly one pound of beef per day to our present population (reckoning two children as one adult).

If these propositions can be sustained, it follows that our present crops of corn, wheat and cotton, and a very much increased product of the dairy and poultry-yard, as well as of meat and wool, can be raised on

352,500 square miles,



or upon twelve per cent of the total area; and even this assign-

ment of land is nearly double what might be required if the *intensive* system of farming were adopted by men of sufficient intelligence and capital to conduct all parts of the work in a reasonably good way.

It is held that in the face of this demonstration the charge that poverty is now to be attributed to monopoly of land in this country is utterly disproved, and that the explanation of extreme poverty must be sought in other directions. It is painfully apparent that extreme poverty is to be found chiefly among those who are foreign born, but there is as much free land open to them as there is to the native born, —enough and to spare for both.

If these propositions can be sustained, it may therefore happen that when the population of the United States of 1880 shall have doubled,— perhaps in the first decade of the next century,— an area of land no larger than that which is assigned in these graphical lines will be required to sustain the people of that day; it may happen that the hundred million people then existing upon our national domain will require a very much less area of soil to sustain them than is now devoted to the subsistence of the present population.

Venture then to imagine one hundred million English-speaking people living in comfort and welfare upon our national domain, even then making use for the necessary purposes of subsistence, of only one acre in eight or ten of our whole area; free from national debt, paying their national taxes under a well devised and intelligent system, meeting their competitors in the commerce of the world with vast quantities of every kind of produce, and of manufactured articles which will have been produced by the application of the best machinery to the greatest natural resources to be found in any similar area of the earth's surface. The working people who will then, as they do now, constitute more than ninety in every hundred of the population, gaining a constantly increasing share of an increasing product with less effort or labor in each decade, as the decades pass.

Can the standing armies of Europe be sustained when the full economic effect and the moral influence of this nation is thus exerted?

The material subjects which we treat are but one phase of that life of which the moral and the spiritual are also integral parts,— each resting upon the other, each more or less dependent upon the other.

Even among the figures and the dry statements of facts with which we are called upon to deal in Section I, may we not therefore find something to arouse the imagination and much to stimulate the higher life which is the end of all our work?

Of a truth the swords shall be beaten into ploughshares and the spears into pruning hooks.

In our far southern land, upon the heights around Chattanooga, were many ramparts within and before which thousands rendered up their lives in order that liberty might be established over all our domain.

Even from death unto life sprang forth the new industry of the new south; those very ramparts are now the walls of the reservoirs which supply the free men of that city with living water.

So may it be in all lands when men learn to serve each other in beneficent commerce and when all the nations of the earth shall have become interdependent.

## STATISTICAL TABLES.

If the basis of the consumption of adult factory operatives, composing a large proportion of females and the lesser proportion of men customarily occupied in or about a cotton factory in the eastern or middle states combined, be adopted as a fair standard for the average per capita consumption of the country, the consumption statement of the present population of 57,000,000 as the equivalent of 50,000,000 adults by computing two children under ten as one adult, would be as follows; the data being compiled from a sufficient number of records between 1880 and 1884, to be reasonably accurate; since the computation prices have fallen considerably. The proportion of tea, coffee and sugar is probably somewhat above the average consumption, women apparently consuming a larger proportion than men.

| | CENTS | CONSUMPTION OF THE U. S. ON THIS BASIS. |
|---|---|---|
| Meat, poultry and fish, per day ½ to 1 lb. | 9.70 | $1,765,000,000 |
| Milk ½ pint, butter 1¼ to 1½ oz., cheese, a scrap, | 5.00 | 912,500,000 |
| Eggs 1 every two days at 12 cents per doz., | .50 | 91,250,000 |
| | 15.20 | $2,768,750,000 |

| | CENTS | CONSUMPTION OF THE U. S. ON THIS BASIS. |
|---|---|---|
| *Amount brought forward* | 15.20 | 2,768,750,000 |
| Cereals, | 2.50 | 456,000,000 |
| Vegetables, | 1.98 | 360,500,000 |
| Sugar or syrup, | 1.94 | 353,000,000 |
| Tea or coffee, | 1.20 | 185,000,000 |
| Fruit, green or dry, | .62 | 113,000,000 |
| Salt, spice, ice, etc. | .49 | 89,000,000 |
| Total per day, | 23.93 | per year, $4,325,250,000 |

The estimates of the cost of drink range from a mimimum which has been established by Mr. David A. Wells after careful research of $474,823,000, to various sums reaching very extravagant figures. It may be fairly computed that the total price of food to consumers is over $5,000,000,000; the price of clothing, carpets and other textile fabrics which are directly used by men and women may be fairly computed at $1,500,000,000.

*Dietary No. 2.*

Fourteen adult men and women in Massachusetts, nine men engaged in mechanical work, three women in mill work, two in the care of the house, for six months in 1885. (Mostly Irish.)

| | CENTS |
|---|---|
| Meat per day, | 9.52 |
| Milk, butter and cheese, | 6.50 |
| Eggs, | 1.40 |
| Total animal food, | 17.42 |
| Cereals, | 4.07 |
| Sugar and syrup, | 1.90 |
| Vegetables, | 1.32 |
| Fruit, green and dry, | 1.17 |
| Tea and coffee, | .70 |
| Sundries, | 2.14 |
| Total cents per day, | 28.73 |

*Dietary No. 3.*

A French Canadian family of ten persons, four adults, six children, two to eighteen years computed at $4\frac{1}{2}$ adults. Total $8\frac{1}{2}$ adults. Massachusetts six months in 1885.

| | CENTS |
|---|---|
| Meat and fish per day, | 5.02 |
| Milk, butter and cheese, | 4.63 |
| Eggs, | .96 |
| Total animal food, | 10.61 |
| Cereals, | 3.00 |
| Vegetables, | 2.82 |
| Sugar and syrup, | 1.87 |
| Fruit, green and dry, | 1.05 |
| Tea and coffee, | .63 |
| Sundries, | 1.81 |
| Total cents per day, | 21.79 |

*Dietary No.* 4.

A well-to-do American family, father and two sons, mechanics, three adults, five children, two under ten years old. Massachusetts, six months in 1885.

| | |
|---|---|
| Meat and fish per day, | 9.70 |
| Milk, butter and cheese, | 6.73 |
| Eggs, | 1.43 |
| Total animal food, | 17.86 |
| Cereals, | 3.83 |
| Vegetables, | 3.21 |
| Fruit, | 3.28 |
| Sugar and syrup, | 1.88 |
| Tea and coffee, | 1.25 |
| Sundries, | 2.53 |
| Total cents per day, | 33.90 |

*Dietary No.* 5.

I am indebted to Mr. J. S. Lord, Chief of the Bureau of Statistics of Illinois, for the most comprehensive statement of the cost of the food of a large number of persons, which I have ever seen, except in the data of armies.

It was prepared by Dr. Fred. H. Wines, Secretary of the Board of Public Charities of Ill., from the accounts of the Public Insane Asylums, Institutions for the Blind, Deaf and Dumb and

Feebleminded and of the State Reform School. This report covers the cost per day of sustaining these institutions for ten years, lacking two months, from Dec. 1, 1874, to Sept. 30, 1884.

The average number of persons fed was 3,293: inmates 2,779, officers and employés 514. The total number of days' board was 11,828,685: inmates 9,981,483, officers and employés 1,847,202.

No account has been kept and no estimate has been officially made of the garden stuff raised on the farms connected with these institutions, nor of milk, nor of pigs and poultry raised and eaten. The statistics cover only the food purchased. The dietary is as follows:

| | CENTS |
|---|---|
| Meat, fish, butter, lard and eggs, per day, | 6.69 |
| Cereals, | 2.34 |
| Vegetables, | .53 |
| Sugar and syrup, | 1.22 |
| Tea and coffee, | .62 |
| Sundries, | 2.09 |
| Total cents per day, | 13.49 |

All purchased at wholesale prices. Dr. Wines estimates the consumption of milk at one-tenth of a gallon per day which at 20 cents a gallon would add two cents per day. He also computes the value of the farm products raised on the farms connected with the institutions at two cents per day each person, which being added to the money paid for provisions would bring the actual ration to about 17 cents per day per person, which is somewhat above the cost of food provided for the prisoners in Massachusetts jails; but due regard being given to the members of skilled officials and employés, to the greater variety of food and to the abundance of vegetables raised, the ration may be considered one of a higher grade.

The inmates of these institutions are all adults or boys except in one case, the Home for Soldiers' Orphans: in the Reform School the ages are fourteen to seventeen.

The quantities of food per capita were as follows, per annum:

| | |
|---|---|
| Breadstuffs (all sorts), | 281.38 pounds. |
| Meats and fish, | 226.12 " |
| Butter, | 28.99 " |
| Cheese, | 3.26 " |

| | |
|---|---|
| Tea, | 2.40 pounds. |
| Coffee, | 7.60 " |
| Sugar, | 36.78 " |
| Rice and hominy, | 5.23 " |
| Fruit bought by the pound, | 10.64 " |
| Total, | 602.40 " |
| Fruit bought by the quart, | 27 quarts. |
| Vegetables reduced to quarts, | 71 " |
| | 98 |
| Oranges and lemons, number, | 4 |
| Eggs, number, | 91 |
| Molasses, vinegar and cider, | 1.22 gallons. |

Average prices paid:

| | |
|---|---|
| Flour (wheat) per barrel, | $6.03 |
| Fresh meat per 100 lbs., | 7.33 |
| Salt meat per 100 lbs., | 5.66 |
| Potatoes per bushel, | .64 |
| Butter per pound, a fraction less than | .22 |
| Tea per pound, | .41 |
| Coffee per pound, | .17 |
| Sugar per pound, | .09 |
| Molasses per gallon, | .49 |
| Eggs per dozen, | .13 |

The expenses of these institutions during this period were $5,869,189.30, of which salaries constituted $2,094,896.86.

The average charge per inmate has been as high as 59½ cents per day and is now 55 cents; but, including officials and employés, the cost per head, no rent being charged, is 46 cents per day per capita.

If we deduct 25 per cent, as the savings of officials and employés, the remainder, $5,345,515 gives an average cost of about 45 cents per day, expended in food, fuel, clothing, repairs, and general expenses, without rent; or if we reduce the salaries of officials and employés by one-half, we still have an average cost of 41 to 42 cents, or at the present time of 37½ cents per head.

This is surprisingly low, and it proves the economy and effi-

ciency of the management of these institutions; but it brings out in a most conspicuous way the close conditions of existence when we compare these figures with the average expenditure per capita in the families of working people and when we recall the fact that a very large proportion must pay rent as well as provide food, fuel and clothing out of what 40 to 45 cents a day will buy.

*Dietary No. 6.*

Fifty-six adult females, factory operatives and the employés in charge of the boarding-house, for six months in 1885, in Maryland.

Food bought by the factory owners at wholesale prices.

| | CENTS |
|---|---|
| Meat and fish, | 6.51 |
| Milk, butter and cheese, | 2.86 |
| Eggs, | .65 |
| Total animal food, | 10.02 |
| Vegetables, | 1.46 |
| Cereals, | 1.73 |
| Sugar and syrup, | 1.30 |
| Tea and coffee, | .90 |
| Fruit, | .35 |
| Salt, spice, etc., | .40 |
| Total cents per day, | 16.16 |

*Dietary No. 7.*

By the kindness of Mr. L. McHugh, Chief of the Bureau of Labor Statistics of Ohio, I have been furnished with the division of the expenses of twenty-seven mechanics' and miners' families in Ohio whose average expenditures ranged for one year from $300 for 2 persons to $1,194 for 6 persons.

Average persons per family $4\frac{70}{100}$.

| | |
|---|---|
| Average expenditure per year | $557.14 |
| Average per person per day | $.32\frac{45}{100}$ |

Subdivision.

| | |
|---|---|
| Rent | 76.52 |
| Food and light | 261.04 |

| | | |
|---|---|---|
| Clothing including boots and shoes and miscellaneous dry goods | 115.42 | |
| Fuel | 32.00 | |
| Sickness | 20.74 | |
| Sundries | 50.42 | |
| | | $557.14 |

Food in this statement costs a little less than 50 per cent of the expenditure at an average of $15\frac{22}{100}$ cents per person per day. At a fair computation this would be at the rate of $17\frac{35}{100}$ cents per day per adult.

*Dietary No. 8.*

A carder in a woollen mill in Rhenish Prussia, supporting his wife and two children of 6 and 8 years, equal to three adults. (From Consul J. S. Potter's report.)

| | PER WEEK. |
|---|---|
| Breakfast: coffee, bread and butter, | .47½ cts. |
| Lunch: bread and butter, sometimes a little meat, | .47½ |
| Dinner: soup, potatoes or other vegetables, occasionally a little meat, | 1.66 |
| Lunch at 4 p. m.: coffee, bread and butter, | .47½ |
| Supper, 8 p. m.: milk, soup and bread, | .47½ |
| Personal luxuries including beer, | .26 |
| Total per week, | $3.82 |

Per day for the equivalent of 3 adults .5455
Per day for each adult $18\frac{18}{100}$ cents.

*Dietary No. 9.*

Condition of a representative workman in a German shoe factory as given in the report of Consul J. S. Potter.

"I am 38 years old and have a wife and three children the oldest 13 and the youngest 6 years of age. I am shoe-dresser in a factory and I am paid 77 cents per day for 12 hours work.

For breakfast we have coffee, bread and butter and some meat for myself.

For dinner: soup with some vegetables and pork.

At 4 o'clock: coffee, bread and sometimes butter.

At 8 o'clock supper: salad, potatoes and bacon sauce and some meat.

My wife earns 94 cents a week and I work extra hours. With our united earnings I can support my family very well and save for the 'sparcasse' from $10 to $12 a year.

My regular yearly wages now amount to $241\frac{33}{100}$.

| | |
|---|---|
| I pay for rent per year, | 32.13 |
| Clothing for self, wife and children, | 41.65 |
| For food and fuel, 44 cents per day, | 160.27 |
| Government tax, | .72 |
| Beer and tobacco, | 6.56 |
| | $241.33 |

My savings are from extra work. When sick we are furnished with medicine and medical attendance, free of cost, the expense for which is paid from a contribution by my employer and a workman's union in the factory.

At the present time (1885) business is very lively and *wages are high.*"

The italics are my own. It will be observed that the cost of food and fuel is $66\frac{2}{3}$ per cent of the expenditure, and if the family is computed at $3\frac{1}{2}$ adults, the cost of food and fuel is $12\frac{57}{100}$ cts. per day.

These two reports give some indications of the comparative conditions of workmen in Germany and in the United States. The money available for food is less in Germany, both in amount and in purchasing power.

Under recent instructions from the Secretary of State, consuls will hereafter report on a uniform plan as to the daily rations of European workmen, giving quantity, price and amount, in a form corresponding to the statements given in this address on the rations in this country.

It needs no argument to prove that the great advantage of this country over all others lies in the huge abundance of the most nutritious food, and since the cost of labor in any given product may be measured by the effectiveness of the labor, rather than by a mere comparison of the rate of wages in money, it becomes important to know the price of food in countries which may compete with us, or which we may be called upon to supply in part.

The problem may be given in these terms:

1. What is the quantity of work performed for a given sum of money?

2. How much of such given sum of money can be devoted to the purchase of food?

3. How much force or energy does such a supply of food represent?

The underfed cannot compete with the well nourished.

So far as the food problem yet affects this country, the only service which science can render is to show what choice should be made as to the kind of food to be purchased, and how it should be prepared.

In Germany, and in many other European states, it has become necessary to teach the people how to get the utmost out of an insufficient supply. For this reason, a great deal of scientific work has been done in Germany, in a direction upon which we have only begun, and the dietary which has been prepared by Dr. Meinert may possess great interest in comparison with both the practice of this country, and the theory which is presented in the table of standard rations given herewith.

The main point of interest, is the very limited variety of food, and the somewhat meagre, even if theoretically sufficient, diet which can be had in Germany at a cost of $18\frac{3}{4}$ cents per day.

For the preparation of translation of the German dietary as well as for all the other tables hereto appended, I am indebted to Prof. Wm. O. Atwater of Middletown, Conn.

I entered upon this statistical inquiry without any full comprehension of the vast importance of the subject. Many of the propositions, which have been generally accepted by economists, such as the law of population propounded by Malthus, the theory of rent of Ricardo, and the so-called law of diminishing returns from land, have never seemed to me to have any true foundation, either in reason or in history, and it was mainly for the purpose of establishing a statistical refutation of these hypotheses that I began to consider the food question.

Upon examining such books as were within my reach, I found the statistics of rations almost wholly wanting, except the data taken from charitable institutions. On consulting the physiologists and biologists, I found that the coöperation of the statisti-

cian was urgently needed by them in the solution of the food problem as it is presented to them.

After consulting with Col. Carroll D. Wright, Chief of the National Bureau of the Statistics of Labor, and presenting the subject for the consideration of the Chiefs of the Labor Bureau of the several states, the following blank was prepared.

THE DAILY RATION OF FOOD OF WORKING PEOPLE IN THE DIFFERENT SECTIONS OF THE COUNTRY.

1. Of what does this ration now consist and what does it cost?

| | | | | CENTS. |
|---|---|---|---|---|
| A. Meat and Fish. | Quantity, | price, | cost, | |
| B. Milk. | " | " | " | |
| Butter. | " | " | " | |
| Cheese. | " | " | " | |
| Eggs. | " | " | " | |
| *Total Animal Food.* | | | | |
| C. Bread: Wheat, | Quantity, | price, | cost, | |
| Corn or Rye. | " | " | " | |
| D. Vegetables. | " | " | " | |
| E. Sugar. | " | " | " | |
| Molasses or Syrup. | " | " | " | |
| F. Tea. | " | " | " | |
| Coffee. | " | " | " | |
| G. Fruit, green, | " | " | " | |
| dry. | " | " | " | |
| H. Salt, Spice, Ice. Pickles and Sundries. | " | " | " | |
| *Totals.* | | | | |

2. What proportion does the average cost of food bear to the total cost of living?

As I have before stated, a similar inquiry is now being made by the Consular Bureau, and it is possible that before the report of this meeting is finally published, the data included will constitute something more than a beginning of the science of the consumption of food.

I trust that you will be so impressed with the importance of this subject, that you will excuse me for the weary length of this address.

I am requested by Prof. Atwater before presenting even a digest of the material which he has placed in my hands subject to my use, to state, that his numerous engagements since I made the request for this treatise have prevented his doing anything more than to dictate a partial answer to my questions, and there has been no time to consider the form or to revise the substance of what he has given me. It is of the utmost value, and I trust that it will all appear, perhaps in connection with his address lately made to the Chiefs of the Bureaus of Labor Statistics of the United States.

The following pages contain only a portion of the extremely valuable information supplied by Prof. W. O. Atwater upon the subject of *A Standard Ration*.

DATA PREPARED BY PROF. W. O. ATWATER.

In answer to the question "What should be the standard or daily ration?" it may be said that the ordinarily accepted standards are estimated in terms of the three most important classes of the nutritive ingredients, or nutrients of food: (1) protein, or albuminoids; (2) fats; (3) carbo-hydrates.

Our best information upon this subject comes from Germany, accurate experiments having been made by Liebig, Moleschott, Pettenkofer, Voit and others. Payen in France; Frankland, Playfair, Lawes and Gilbert, in England, have also made most valuable contributions to the knowledge upon this subject.

I cannot forbear noting the fact, however, that very little attention appears to have been paid to the results of these experiments on this side of the Atlantic, or, for that matter, in England: even in some of the best text-books in chemistry and physiology, those which are looked upon as most authoritative are too apt to pass the subject over most superficially, or almost to ignore it.

The standard rations assumed by Prof. Voit of Munich are more commonly accepted than any others, and are most frequently quoted and followed in estimating dietaries.

The following are standards adopted by the Munich school of physiological chemists who follow Voit.

STANDARD RATIONS.

| | PROTEIN. | FATS. | CARBOHYDRATES. |
|---|---|---|---|
| | *grammes* | *grammes* | *grammes* |
| Children to 1½ years. | 20–36 | 30–45 | 60–90 |
| " from 6 to 15 years. | 70–80 | 37–50 | 250–400 |
| Laboring man at moderate work. | 118 | 56 | 500 |
| " " " severe " | 145 | 100 | 450 |
| Laboring woman. | 92 | 44 | 400 |
| Aged man. | 100 | 68 | 350 |
| Aged woman. | 80 | 50 | 260 |

We are of course to understand that these figures represent only general averages. It is assumed that for an ordinary laboring man doing an ordinary amount of work, the amounts of nutrients above given will suffice, and that with them he will hold his own; that with much less he will lose flesh and fat, and grow weak; and that any considerable excess above these quantities will be superfluous. But of course no one expects any given man to adjust his diet exactly to this standard; he may need more, and may perhaps get on with less. He may eat more fats and less carbohydrates, and more protein, if he is willing to pay for it. If, however, he eats much less protein, and keeps up his muscular exertion, he will, in Prof. Voit's opinion, be apt, sooner or later, to suffer.

Protein is the costliest of the food ingredients, and hence the one which, from the pecuniary standpoint most needs to be economized; and since, furthermore, its work of building up muscles, tendons and the like, cannot be done by either of the other classes of nutrients, since, in other words, it is very expensive,—one of the first questions in constructing an economical ration is, "What is the least amount of protein that will suffice." This question cannot be answered exactly until we know more than we now do about the demands of different organisms under different conditions. The subject needs more thorough and experimental study.

To resume briefly. In computing standard rations to supply sufficient food at the minimum cost, we have to learn.

1st.—What is the minimum quantity of the most costly ingredient, viz., protein?

2d.—What proportion of nutrients are contained in the food materials we are to use?

The flavor of the food and the special fitness of the different kinds must of course be considered. We are as yet only on the threshold of our knowledge of these matters. I ought not to dismiss this subject without adding a word upon the digestibility of foods, and the quantities needed. Many experiments have been made to determine the proportions of the different nutrients that are actually digested by a healthy man. Meats and fish are more completely digested than vegetable foods. 99 per cent has been found to be digested by a healthy man, only one or two per cent being wasted, while, of course, of bread one-fourth or one-third might pass through the alimentary canal undigested.

But lack of complete data as well as of time for discussion precludes further reference to the matter.

### EXAMPLES OF GERMAN RATIONS, CORRESPONDING TO THIS STANDARD, AND THEIR PRICE.

Of late a great deal of attention has been paid, in Germany, to this particular subject of the food of the people, and the best ways to economize it. I noticed a statement in a scientific journal, a few days ago, that Bismark had engaged Professor König to prepare a series of schedules of rations for ordinary German laboring people, which, I suppose, actually means that one of the departments of the Prussian governmant has engaged Professor König, who is one of the principal authorities in this line, to carry out this enterprise. Numerous attempts have already been made in this same direction. I have before me, for instance, a little brochure, of about one hundred pages by Dr. Meinert, entitled "*Wie nährt man sich gut und billig?*" "How can one feed himself well and economically." That this is regarded as trustworthy is evinced by the fact that it was honored with a prize, offered by an association and awarded by a committee consisting of Professors Voit, Foster, and Beneke, three of the best known German authorities in this specialty. It tells in plain language about foods, their constituents, the proportions of the several nutrients in various foods, the relative cheapness and dearness of different food materials as shown by the comparison of their composition with their price, and with the rest gives schedules of daily rations for families. There are three of these schedules, the first intended for a family with an annual income of 800 marks, $200.00, of which it is assumed that 60 per cent will be expended

for food. The second is for a family with an income of 1100 marks, or $275.00, and the third for one of 1500 marks, or $375.00 per annum. The outlay for the food of each of the two last is to be about 53 per cent of the income. As the largest of the three incomes would be counted very small with us, I have selected the schedule corresponding to it rather than either of the others, for the translation which I have caused to be made and included herewith.

*Dietary for a family for two weeks.*

The following dietary is calculated for a family consisting of father, mother and two children of ten and twelve years of age.

The annual income for the support of the family is taken at 1500 marks or $375, of which 53 per cent, 800 marks, per year, or $200 which would allow 220 pfennigs or fifty-five cents per day, is to be spent for food. It is assumed that the mother and two children will require as much nutritive material in their food as two laboring men, so that the family of four persons will be equal in their demand to three laboring men. Dr. Meinert further assumes that to earn so large a sum as 1500 marks per year, more than ordinarily hard work will be required; and hence, following Professor Voit's figures for rations, he provided for a ration with nutrients a little in excess of the standard for a laboring man at moderate work. Professor Voit's standards for an ordinary laboring man doing moderately hard work, and for the same man at severe work, are stated below and with them Dr. Meinert's standard for the family in question.

NUTRIENTS IN DAILY RATION.

| Nutrients. | PROF. VOIT'S STANDARDS. | | Dr. Meinert's standard for family with 1500 marks per year. |
|---|---|---|---|
| | For laboring man at moderate work. | For laboring man at severe work. | |
| Protein. | 118 grams (0.26 lb.) | 145 grams. | 120 grams. |
| Fats. | 56 " (0.12 lb.) | 100 " | 70 " |
| Carbo hydrates. | 500 " (1.10 lbs.) | 450 " | 500 " |

As the family are accounted equivalent to three "laboring men" the 220 pfennigs allowed for food per day must pay for three rations which gives 73.3 pfennigs per ration. The problem then is

to draw up a bill of fare for each day, which shall furnish a minimum of 120 grams or 0.27 lbs. of protein, 70 grams or 0.15 lbs. of fats, and 500 grams or 1.10 lbs. of carbohydrates for 73.3 pfennigs or $18\frac{3}{4}$ cents per day, in food materials such as a German laborer may properly use and at such prices as he must pay for them.

In accordance with German usage provision is to be made for breakfast, dinner at midday, lunch (Vesperbrot) in the afternoon and supper (Abendessen). The following is Dr. Meinert's outline of the bill of fare for two weeks.

BILL OF FARE FOR FOURTEEN DAYS.

| DAY. | BREAKFAST. | DINNER. | LUNCH. | SUPPER. |
|---|---|---|---|---|
| 1st | Coffee, milk, rolls, black bread, butter. | Fresh haddock with mustard sauce and potatoes. | Coffee and milk. Bread and butter. | Meat and vegetable soup. |
| 2d | " | Beef stew with Kohlrabi and potatoes. | " | Cheese and beer. |
| 3d | " | Sausage with and beer. | " | Onion soup. |
| 4th | " | Mutton and beans. | " | Potato soup. |
| 5th | " | with bacon and beer. | " | Pea soup. |
| 6th | " | | " | Herring and beer. |
| 7th | " | Dried codfish with sauerkraut, peas and beer. | " | Buttermilk soup. |
| 8th | " | Hashed meats with potato soup. | " | Meat and vegetable soup. |
| 9th | " | Sausage (*Bludwurst*) with lentils and beer. | " | Potatoes and |
| 10th | " | Liver with potato salad. | " | Cheese and beer. |
| 11th | " | Beefsteak with cabbage and potatoes. | " | Bread and milk soup. |
| 12th | " | Herring, potatoes and beer. | " | Meat and vegetable soup. |
| 13th | " | Pork with cabbage and potatoes. | " | Cheese and beer. |
| 14th | " | Liver with spinach, potatoes and beer. | " | Oatmeal in buttermilk. |

The details of the daily bills of fare are given by Dr. Meinert in the forms translated beyond. The quantities are given in the metric weights and measures current in Germany. It will be remembered that the kilogram consists of 1,000 grams and equals about 2.2 lbs.; that the gram is nearly 15.5 grains, and roughly speaking, 450 grams make a pound and 28 grams an ounce. The liter is 1,000 cubic centimeters, a little over a quart; a liter of water weighs 1 kilogram. The mark consists of 100 pfennigs and is worth about twenty-five cents, so that the pfennig is one-quarter of a cent. Translating these into our own weights and measures would, I think, rather detract from than add to their clearness and value. In their present form they are simple, but would by recalculation become more complex. In the summary at the end the quantities and prices are given in American weights and money.

In translating I will for convenience speak of the first and second breakfast together as breakfast. The midday and evening meals we will call dinner and supper and will follow Dr. Meinert's example in including the afternoon lunch with breakfast.

In this dietary Dr. Meinert gives first a general schedule for breakfast and lunch, which (or its equivalent) is to serve for each of the fourteen days. The schedule for dinner and supper for each several day is given by itself. It is assumed that the material left over at one time will serve for another, and that thus the evening meals may be filled out from what is left at breakfast or dinner.

BREAKFAST AND LUNCH.

| AMOUNT OF FOOD AND PRICE. | AMOUNT IN GRAMS. | Price per kilo or liter in pfennigs. | Price of the amount indicated in pfennigs. | AMOUNT OF | | |
|---|---|---|---|---|---|---|
| | | | | Protein. grams. | Fats grams. | Carbo-hydrates. grams. |
| 4 Wheat rolls. | 290 | | 12 | 15 | 2 | 148 |
| Rye bread. | 1500 | 24 | 36 | 90 | 9 | 750 |
| Coffee and trimmings. | 60 | | 9 | 5 | 1 | 28 |
| 1¼ liters skimmed milk. | 1250 | 8 | 10 | 38 | 6 | 50 |
| Butter. | 100 | 240 | 24 | | 98 | |
| Salt. | 75 | 20 | 1.5 | | | |
| 2 liters beer. | 2000 | 12 | 24 | 10 | | 160 |
| | | | 116.5 | 158 | 116 | 1136 |
| Per head and day. | | | 38.8 | 53 | 39 | 379 |
| There remains for dinner and supper. | | | 34.5 | 67 | 31 | 121 |
| Total per head per day | | | 73.3 | 120 | 70 | 500 |

It will be observed that the cost of each material is stated, with the amounts of nutrients it contains. By "per head" is understood for one laboring man. It will be remembered that the mother and two children were assumed to require as much as two laboring men.

Here follow details of dinner and supper, and summary for each of the 14 days.

BILL OF FARE FOR DINNER AND SUPPER FOR FOURTEEN DAYS.

| AMOUNT OF FOOD | Amount in grams. | Price per kilo or liter in pfennigs. | Price of the amount indicated in pfennigs. | AMOUNT OF | | | |
|---|---|---|---|---|---|---|---|
| | | | | Protein grams. | Fats grams. | Carbohydrates grams. | |
| Fresh haddock. | 500 | 80 | 40 | 60 | 5 | 8 | FIRST DAY. Dinner.—Codfish with mustard sauce and potatoes. Supper.— Meat and vegetable soup. |
| Mustard. | 125 | 80 | 10 | 33 | 42 | 31 | |
| Flour | 50 | 40 | 2 | 6 | — | 35 | |
| Fat (lard, butter) | 60 | 130 | 8 | — | 57 | — | |
| Potatoes | 2500 | 7 | 17.5 | 50 | 3 | 500 | |
| "Fleischgemüse"[1] | 125 | 200 | 25 | 40 | 22 | 44 | |
| | | | 102.5 | 189 | 129 | 618 | |
| Per head. | | | 34.2 | 63 | 43 | 206 | |
| For breakfast, lunch, etc. | | | 38.8 | 53 | 39 | 379 | |
| Total per head and day. | | | 73.0 | 116 | 82 | 585 | |
| Beef | 500 | 120 | 60 | 80 | 40 | — | SECOND DAY. Dinner.— |
| Fat (lard, butter, etc.) | 100 | 130 | 13 | — | 95 | — | |
| Kohlrabi | 1000 | 15 | 15 | 27 | 2 | 86 | |
| Potatoes | 1500 | 7 | 10.5 | 30 | 3 | 300 | |
| Skim-milk cheese | 300 | 50 | 15 | 120 | 21 | — | Supper.— Cheese and beer. |
| | | | 113.5 | 257 | 161 | 386 | |
| Per head. | | | 37.8 | 86 | 54 | 129 | |
| For breakfast lunch, etc. | | | 38.8 | 53 | 39 | 379 | |
| Total per head and day. | | | 76.6 | 139 | 93 | 508 | |

[1] "Fleischgemüse," soup made from a mixture of preserved South American meat and vegetables especially recommended by Dr. Meinert.

| AMOUNT OF FOOD. | Amount in grams. | Price per kilo or liter in pfennigs. | Price of the amount indicated in pfennigs. | AMOUNT OF | | | |
|---|---|---|---|---|---|---|---|
| | | | | Protein grams. | Fats. grams. | Carbohydrates. grams. | |
| Millet. | 500 | 40 | 20 | 56 | 17 | 290 | THIRD DAY. Dinner.— |
| Skimmed milk. | 1500 | 8 | 12 | 45 | 7 | 60 | |
| Sausage. | 300 | 180 | 54 | 69 | 33 | 21 | |
| Onions. | 150 | 10 | 1.5 | 4 | — | 12 | |
| Fat. | 50 | 130 | 6.5 | — | 47 | — | |
| Flour. | 150 | 40 | 6.0 | 17 | 2 | 105 | Supper.— Onion soup. |
| | | | 100.0 | 191 | 106 | 488 | |
| Per head. | | | 33.3 | 64 | 35 | 163 | |
| For breakfast, lunch, etc. | | | 38.8 | 53 | 39 | 379 | |
| Total per head and day. | | | 72.1 | 117 | 74 | 542 | |
| Mutton. | 500 | 120 | 60 | 75 | 50 | — | FOURTH DAY. Dinner.— Mutton and beans. |
| Beans. | 500 | 40 | 20 | 130 | 10 | 250 | |
| Fat. | 100 | 130 | 13 | — | 95 | — | |
| Potatoes. | 2000 | 7 | 14 | 40 | 2 | 400 | Supper.— Potato soup. |
| | | | 107 | 245 | 157 | 650 | |
| Per head. | | | 35.6 | 82 | 52 | 216 | |
| For breakfast, lunch, etc. | | | 38.8 | 53 | 39 | 379 | |
| Total per head and day. | | | 74.4 | 135 | 91 | 595 | |
| "Fleischgraupen" | 450 | 150 | 68 | 100 | 10 | 300 | FIFTH DAY. Dinner.— |
| Bacon. | 125 | 160 | 20 | 3 | 98 | — | |
| Pease. | 300 | 50 | 15 | 67 | 6 | 150 | |
| Lard. | 40 | 170 | 7 | — | 37 | — | |
| Spices. | — | — | 2 | — | — | — | Supper.— Pea soup. |
| | | | 112 | 170 | 151 | 450 | |
| Per head. | | | 37.3 | 57 | 50 | 150 | |
| For breakfast, lunch, etc. | | | 38.8 | 53 | 39 | 379 | |
| Total per head and day. | | | 76.1 | 110 | 89 | 529 | |

| AMOUNT OF FOOD. | Amount in grams. | Price per kilo or liter in pfennigs. | Price of the amount indicated in pfennigs. | AMOUNT OF | | | |
|---|---|---|---|---|---|---|---|
| | | | | Protein grams. | Fats. grams. | Carbohydrates. grams. | |
| Wheat flour, | 600 | 45 | 27 | 66 | 6 | 438 | SIXTH DAY. Dinner.— Dumplings with fruit. |
| Potatoes, | 1500 | 7 | 10.5 | 30 | 1.5 | 300 | |
| Wheat rolls, | 72 | — | 3 | 4 | — | 35 | |
| Fat | 100 | 130 | 13 | — | 95 | — | |
| Fruit, | 250 | 80 | 20 | 8 | 2.5 | 113 | |
| Sugar, | 30 | 100 | 3 | — | — | 27 | Supper.— Herring and beer. |
| Herrings, | 260 | 7 | 21 | 52 | 32 | 5 | |
| | | | 97.5 | 160 | 137.0 | 918 | |
| Per head. | | | 32.5 | 53 | 46 | 306 | |
| For breakfast, lunch, etc. | | | 38.8 | 53 | 39 | 379 | |
| Total per head and day. | | | 71.3 | 106 | 85 | 685 | |
| Dried codfish, | 250 | 140 | 35 | 198 | 3 | — | SEVENTH DAY. Dinner.—Dried codfish, with sauerkraut, pease and beer. |
| Sauerkraut, | 1000 | 18 | 18 | 10 | 2 | 46 | |
| Pease, | 300 | 50 | 15 | 67 | 3 | 150 | |
| Fat, | 100 | 130 | 13 | — | 95 | — | |
| Buttermilk, 2 liters. | 2000 | 6 | 12 | 51 | 15 | 15 | Supper.— Butter milk soup. |
| | | | 93 | 326 | 118 | 211 | |
| Per head. | | | 31 | 109 | 39 | 70 | |
| For breakfast, lunch, etc. | | | 38.8 | 53 | 39 | 379 | |
| Total per head and day. | | | 69.8 | 162 | 78 | 449 | |

| AMOUNT OF FOOD. | Amount in grams. | Price per kilo or liter in pfennigs. | Price of the amount indicated in pfennigs. | AMOUNT OF | | | |
|---|---|---|---|---|---|---|---|
| | | | | Protein grams. | Fats grams. | Carbohydrates. grams. | |
| Beef, | 200 | 120 | 24 | 32 | 16 | — | EIGHTH DAY. Dinner.—Hashed meats with potato soup. |
| Pork, | 100 | 130 | 13 | 14 | 10 | — | |
| Mutton, | 125 | 120 | 15 | 20 | 8 | — | |
| Fat, | 60 | 130 | 8 | — | 56 | — | |
| Spices and vegetables, | 40 | 3 | — | — | — | — | |
| Potatoes, | 3000 | 7 | 21 | 60 | 3 | 600 | Supper.—Meat and vegetable soup. |
| "Fleischgemüse," | 125 | 200 | 25 | 40 | 22 | 46 | |
| | | | 106 | 166 | 115 | 646 | |
| Per head. | | | 35.3 | 55 | 38 | 215 | |
| For breakfast, lunch, etc. | | | 38.5 | 53 | 39 | 379 | |
| Total per head and day. | | | 74.1 | 108 | 77 | 594 | |
| Sausage. | 300 | 160 | 48 | 35 | 34 | 78 | NINTH DAY. Dinner.—Sausage and lentils. |
| Lentils. | 500 | 50 | 25 | 125 | 10 | 250 | |
| Vinegar. | — | — | 3 | — | — | — | |
| Curd. | 250 | 40 | 10 | 43 | 8 | 7 | Supper.—Potatoes and curd. |
| Potatoes. | 2500 | 7 | 17.5 | 50 | 3 | 500 | |
| | | | 103.5 | 253 | 55 | 835 | |
| Per head. | | | 34.5 | 84 | 18 | 278 | |
| For breakfast, lunch, etc. | | | 38.8 | 53 | 39 | 379 | |
| Total per head and day. | | | 73.3 | 137 | 57 | 657 | |

| AMOUNT OF FOOD | Amount in grams. | Price per kilo or liter in pfennigs. | Price of the amount indicated in pfennigs. | AMOUNT OF | | | |
|---|---|---|---|---|---|---|---|
| | | | | Protein grams. | Fats. grams. | Carbohydrates grams. | |
| Liver and lungs. | 500 | 80 | 40 | 97 | 27 | 10 | TENTH DAY. Dinner.—Liver with potato salad. |
| Lard. | 40 | 1.70 | 6.8 | — | 36 | — | |
| Wheat rolls. | 156 | — | 6 | 6 | 1.5 | 78 | |
| Flour. | 40 | 40 | 1.6 | 4 | 0.5 | 28 | |
| Onions. | 50 | 10 | .5 | 1 | — | 4 | |
| Pepper and vegetables. | 60 | — | 1.6 | — | — | — | |
| Potatoes. | 2500 | 7 | 17.5 | 50 | 2.5 | 500 | |
| Vinegar and oil. | — | — | 5 | — | — | — | |
| Cheese. | 300 | 50 | 15 | 120 | 21 | — | Supper.—Cheese and beer. |
| | | | 94.0 | 278 | 88.5 | 620 | |
| Per head. | | | 31.3 | 93 | 29 | 207 | |
| For breakfast, lunch, etc. | | | 38.8 | 53 | 39 | 379 | |
| Total per head and day. | | | 70.1 | 146 | 68 | 586 | |
| Beefstake. | 400 | 160 | 64 | 88 | 20 | — | ELEVENTH DAY. Dinner.—Beefsteak with cabbage and potatoes. |
| Lard. | 60 | 170 | 10 | — | 57 | — | |
| Red cabbage. | 1000 | 15 | 15 | 18 | 2 | 70 | |
| Potaotes. | 1500 | 7 | 10.5 | 30 | 1 | 300 | |
| Bread. | 300 | 24 | 7 | 18 | 3 | 150 | Supper.—Bread and milk soup. |
| Skimmed milk. | 1500 | 8 | 12 | 45 | 7 | 60 | |
| | | | 118.5 | 199 | 90 | 580 | |
| Per head. | | | 39.5 | 63 | 30 | 193 | |
| For breakfast, lunch etc. | | | 38.8 | 53 | 39 | 379 | |
| Total per head and day | | | 78.3 | 116 | 69 | 572 | |

| AMOUNT OF FOOD. | Amount in grams. | Price per kilo or liter in pfennigs. | Price of the amount indicated in pfennigs. | AMOUNT OF | | | |
|---|---|---|---|---|---|---|---|
| | | | | Protein grams. | Fats. grams. | Carbohydrates. grams. | |
| Three herrings. | 260 | 7[2] | 21 | 52 | 32 | 5 | TWELFTH DAY. Dinner.— Herring and potatoes, beer. |
| Potatoes. | 3000 | 7 | 21 | 60 | 3 | 600 | |
| Skimmed milk. | 1000 | 8 | 8 | 30 | 4 | 40 | |
| Flour. | 50 | 40 | 2 | 5 | 0.5 | 35 | |
| Onions. | 50 | 10 | 0.5 | 1 | 0.5 | 3 | |
| Lard. | 50 | 170 | 8.5 | — | 47 | — | |
| Spices. | — | — | 1.5 | — | — | — | |
| "Fleischgemüse." | 125 | 200 | 25 | 40 | 22 | 46 | Supper.— Meat and vegetable soup. |
| | | | 87.5 | 188 | 109.0 | 729 | |
| Per head. | | | 29.2 | 63 | 36 | 243 | |
| For breakfast, lunch, etc. | | | 38.8 | 53 | 39 | 379 | |
| Total per head and day. | | | 68.0 | 116 | 75 | 622 | |
| Pork. | 500 | 130 | 65 | 67 | 60 | — | THIRTEENTH DAY. Dinner.— Pork with white cabbage and potatoes. |
| Cabbage. | 1000 | 10 | 10 | 20 | 1 | 66 | |
| Potatoes. | 2000 | 7 | 14 | 40 | 2 | 400 | |
| Lard. | 50 | 170 | 8.5 | — | 47 | — | |
| Cheese. | 300 | 50 | 15 | 120 | 21 | — | Supper.— Cheese and beer. |
| | | | 112.5 | 247 | 131 | 466 | |
| Per head. | | | 37.5 | 82 | 44 | 155 | |
| For breakfast, lunch, etc. | | | 38.8 | 53 | 39 | 379 | |
| Total per head and day. | | | 76.3 | 135 | 83 | 534 | |

[2] At 7 pfennigs each.

| AMOUNT OF FOOD | Amount in grams. | Price per kilo or liter in pfennigs. | Price of the amount indicated in pfennigs. | AMOUNT OF Protein grams. | Fats. grams. | Carbohydrates. grams. | |
|---|---|---|---|---|---|---|---|
| Liver. | 500 | 100 | 50 | 175 | 15 | — | FOURTEENTH DAY. Dinner.—Liver with vegetables and potatoes, beer. |
| Spinach. | 1000 | 15 | 15 | 20 | 2 | 60 | |
| Potatoes. | 2000 | 7 | 14 | 40 | 2 | 400 | |
| Fat. | 80 | 130 | 10 | — | 75 | — | |
| Oatmeal. | 150 | 60 | 9 | 23 | 9 | 96 | Supper.—Oatmeal in buttermilk. |
| Buttermilk. | 1000 | 6 | 6 | 34 | 10 | 10 | |
| | | | 104 | 292 | 113 | 566 | |
| Per head. | | | 35 | 97 | 38 | 189 | |
| For breakfast, lunch, etc. | | | 38.8 | 53 | 39 | 379 | |
| Total per head and day. | | | 73.8 | 150 | 77 | 568 | |

## RATIONS OF COMMON FOOD MATERIALS ESTIMATED TO CONTAIN THE AMOUNTS OF NUTRITIVE INGREDIENTS IN THE STANDARD RATION, WITH COST OF EACH.

The following rations have been calculated by my assistant, Mr. Rockwood, mostly from results of analysis made in our laboratory in behalf of the Smithsonian Institution (U. S. National Museum) as a basis for its explanation of its food collection. No other considerable series of analysis of American food materials has, so far as I am aware, been executed, hence, though the data are meagre they are the best available; they are probably not far out of the way. Mr Rockwood has endeavored to construct one series of rations at a very low cost, eleven or twelve cents a day or thereabouts, and another series at higher rates, up to forty-five cents a day. Of course it is not proposed that any person or family should attempt to follow these exactly. For that matter the chemist will evidently have to consult the cook if he proposes to construct rations to accord with ordinary tastes. The rations will, nevertheless, help to show how foods may be economized, and what proportions would suffice for the nourishment of ordi-

nary people, and what are the constituents and costs of the different materials.

DAILY RATIONS COMPUTED TO FURNISH NUTRIENTS EQUIVALENT TO THOSE OF STANDARD FOR LABORING MAN AT MODERATE WORK.

Standard Ration:—Protein (118 grams) 0.26 lb.; fats (56 grams) 0.12 lbs.; carbohydrates (500 grams) 1.10 lbs.

*A. Daily Rations costing 12 cents or less.*

| Food materials. | | | Food materials. | | |
|---|---|---|---|---|---|
| Kinds. | Amounts. | Costs. | Kinds. | Amounts. | Costs. |
| **No. 1.** | | | **No. 6.** | | |
| Beef, neck, | ½ lb. | 4 cts. | Smoked herring, | ¼ lb. | 3 cts. |
| Beans, | ¼ " | ¾ " | Potatoes, | 1 " | 1 " |
| Potatoes, | 2 " | 2 " | Beans, | ¼ " | 1½ " |
| Oatmeal, | ¼ " | 1½ " | Wheat flour, | 1 " | 4 " |
| Butter, | ½ oz. | 1½ " | Butter, | 1-16 " | 2 " |
| Rye flour, | ½ lb. | 1½ " | Total, | | 11½ " |
| Total, | | 10¾ | | | |
| **No. 2.** | | | **No. 7.** | | |
| Beef, shin, | ½ lb. | 3 cts. | Beef, neck, | ½ lb. | 4 cts. |
| Oatmeal, | " " | 2½ " | Beef, shin, | " " | 3 " |
| Corn meal, | " " | 1 " | Alewives, | 1 " | 3 " |
| Milk, ½ pt., | " " | 2 " | Beans, | ½ " | ¾ " |
| Potatoes, | 1 lb. | 1 " | Milk, ½ pt., | ½ " | 2 " |
| Butter, | 1 oz. | 2 " | Rye flour, | " " | 1½ " |
| Total, | | 11½ " | Wheat flour, | " " | 2 " |
| **No. 3.** | | | Oatmeal, | ¾ " | 3¾ " |
| Herring, | ½ lb. | 3 cts. | Corn meal, | 1 " | 3 " |
| Oatmeal, | ¼ " | 1¼ " | Potatoes, | 5 " | 5 " |
| Potatoes, | 1 " | 1 " | Butter, | 2¾ oz. | 5½ " |
| Wheat flour, | 1 " | 4 " | Total, for 3 men, | | 33¼ " |
| Butter, | 1-16 " | 2 " | " " 1 man, | | 11 |
| Total, | | 11¼ " | **No. 8.** | | |
| **No. 4.** | | | Beef, neck, | ½ lb. | 4 cts. |
| Beef, shin, | ½ lb. | 3 cts. | Beef, shin, | " " | 3 " |
| Potatoes, | 3 " | 3 " | Rye flour, | " " | 1¼ " |
| Wheat flour, | ½ " | 2 " | Sugar, | 1½ oz. | 1 " |
| Beans, | ½ " | ¾ " | Oatmeal, | ½ lb. | 2½ " |
| Butter, | 1-16 " | 2 " | Herring, | 1 " | 6 " |
| Sugar, | 1 ½ oz. | 1 " | Beans, | 10 oz. | 2⅝ " |
| Total, | | 11¾ " | Wheat flour, | 2½ lb. | 10 " |
| **No. 5.** | | | Potatoes, | 7 " | 7 " |
| Alewives, | 1 lb. | 3 cts. | Butter, | 3¾ oz. | 7¼ " |
| Potatoes, | 2 " | 2 " | Total, for 4 men, | | 44⅝ " |
| Corn meal, | ½ " | 1½ " | " " 1 man, | | 11⅞ " |
| Wheat flour, | ½ " | 2 " | | | |
| Butter, | 1-16 " | 2 " | | | |
| Total, | | 10½ " | | | |

*B. Daily rations costing from 12 to 15 cents.*

| Food-materials. | | | Food-materials. | | |
|---|---|---|---|---|---|
| Kinds. | Amounts. | Costs. | Kinds. | Amounts. | Costs. |
| No. 9. | | | No. 14. | | |
| Liver, | ½ lb. | 5 cts. | Fresh mackerel, | ¾ lb. | 4½ cts. |
| Potatoes, | 1 " | 1 " | Potatoes, | 1 " | 1 " |
| Butter, | 1-16" | 2 " | Cracked wheat, | ½ " | 3 " |
| Cornmeal, | 1 " | 3 " | Cornmeal, | " " | 1½ " |
| Bread, | ½ " | 3 " | Beans, | ¼ " | ¾ " |
| | | | Butter, | 1 oz. | 2 " |
| Total, | | 14 " | Total, | | 12¾ " |
| No. 10. | | | No. 15. | | |
| Beef, shin, | ¼ lb. | 3 " | | | |
| Bread, | ½ " | 2½ " | Beef, neck, | ½ " | 4 cts. |
| Potatoes, | 1 " | 1 " | Potatoes, | 1 " | 1 " |
| Oatmeal, | ¼ " | 1¼ " | Cornmeal, | ½ " | 1½ " |
| Cornmeal, | ½ " | 1½ " | Rye bread, | 1 " | 4 " |
| Butter, | 1-16" | 1 " | Butter, | 1 oz. | 2 " |
| Sugar, | 1-32" | ¼ " | | | |
| Milk, | ¼ " | 2 " | Total, | | 12½ " |
| Total, | | 15½ " | No. 16, for 3 men. | | |
| No. 11. | | | Liver, | ½ " | 5 " |
| | | | Beef, shin (soup), | " " | 3 " |
| Salt cod, | ½ lb. | 3½ " | Salt codfish, | " " | 3½ " |
| Oatmeal, | " " | 2½ " | Salt pork, | ½ oz. | 2 " |
| Cornmeal, | " " | 1 " | Crackers (pilot), | 1 lb. | 5½ " |
| Milk, | " " | 2 " | Pease, | ½ " | 3 " |
| Butter, | 1 oz. | 2 " | Sugar, | ½ oz. | ¼ " |
| Potatoes, | 2 lbs. | 2 " | Milk, | ¼ lb. | 2 " |
| | | | Oatmeal, | " " | 1¼ " |
| Total, | | 13 " | Potatoes, | 2 lbs. | 2 " |
| | | | Bread, | 1 " | 6 " |
| | | | Butter, | 2 oz. | 4 " |
| No. 12. | | | Cornmeal, | 1½ lb. | 4½ " |
| Pork, | ⅛ lb. | 2 " | Total, for 3 men, | | 42 " |
| Beans, | ¼ " | 1¼ " | " " 1 man, | | 14 " |
| Salt cod, | " " | 2 " | | | |
| Potatoes, | 1½ lbs. | 1½ " | | | |
| Bread, | 1¼ " | 6 " | No. 17, for 4 men. | | |
| Total, | | 12¾ " | Beef, shin, | ¼ lb. | 3 " |
| | | | Fresh mackerel, | ¾ " | 4½ " |
| | | | Salt cod, | " " | 5½ " |
| No. 13. | | | Pork, | 2 oz. | 2 " |
| | | | Beans, | ½ lb. | 1½ " |
| Salt codfish, | ½ lb. | 3½ " | Wheat bread, | 1¾ " | 8¾ " |
| Salt pork, | ⅛ " | 2 " | Cracked wheat, | ½ " | 3 " |
| Crackers (pilot), | 1 " | 5½ " | Cornmeal, | 1½ " | 4½ " |
| Pease, | ½ " | 3 " | Oatmeal, | ¾ " | 4 " |
| | | | Butter, | 3 oz. | 6 " |
| Total, | | 14 " | Milk, | ¾ lb. | 4 " |
| | | | Potatoes, | 5½ " | 5½ " |
| | | | Sugar, | ½ oz. | ¼ " |
| | | | Total, for 4 men, | | 52¼ " |
| | | | " " 1 man, | | 13 " |

*C. Daily rations costing from 15 to 20 cents.*

| Food-materials. | | | Food-materials. | | |
|---|---|---|---|---|---|
| Kinds. | Amounts. | Costs. | Kinds. | Amounts. | Costs. |
| No. 18. | | | No. 22. | | |
| Beef, neck, | ¼ lb. | 2 cts. | Pork, | ½ oz. | ½ " |
| Salt cod, | " " | 1½ " | Beans, | 3 " | 2 " |
| Potatoes, | 1 " | 1 " | Fresh cod, | ½ lb. | 3½ " |
| Bread, | ½ " | 3 " | Potatoes, | 1½ lbs. | 1½ " |
| Cabbage, | 2 oz. | ¼ " | Rye bread, | 1 " | 4 " |
| Turnips, | " " | ⅛ " | Butter, | 1 oz. | 2 " |
| Carrots, | " " | " " | Sugar, | 2 " | 1½ " |
| Oatmeal, | " " | ⅝ " | Milk, | 1 lb. | 3½ " |
| Milk, 1 pt., | 1 lb. | 3½ " | | | |
| Rice, | 2 oz. | 1⅛ " | Total, | | 18½ " |
| Sugar, | " " | 1¼ " | | | |
| Corn meal, | ¼ lb. | ¾ " | | | |
| Soda crackers, | 1 oz. | " " | No. 23, for 3 men. | | |
| Butter, | " " | 2 " | | | |
| Total, | | 18 " | Round steak, | ½ lb. | 9 cts. |
| | | | Beef, neck, | ¼ " | 2 " |
| No. 19. | | | Fresh haddock, | ½ " | 3½ " |
| | | | Salt cod, | ¼ " | 1½ " |
| Round steak, | ½ lb. | 8 " | Fat pork, | ½ oz. | ¼ " |
| Milk, | " " | 2 " | Beans, | 3 " | 2 " |
| Butter, | 1 oz. | " " | Milk, | 2½ lbs. | 9 " |
| Cheese, | " " | 1 " | Cheese, | 1 oz. | 1 " |
| Bread, | ½ lb. | 2½ " | Butter, | 3 " | 6 " |
| Potatoes, | 1½ lbs. | 1½ " | Wheat bread, | 1 lb. | 5 " |
| Sugar, | 1½ oz. | 1 " | Rye bread, | " " | 4 " |
| Turnips, | ⅓ lb. | ½ " | Soda crackers, | " oz. | ¾ " |
| Cornmeal, | ⅛ " | 1 " | Oatmeal, | 2 " | ⅝ " |
| | | | Cornmeal, | 7-12 lb. | 1¾ " |
| Total, | | 19½ " | Rice, | 2 oz. | 1⅛ " |
| | | | Carrots, | " " | ⅛ " |
| No. 20. | | | Turnips, | 10 " | ⅝ " |
| | | | Potatoes, | 4 lbs. | 4 " |
| Beef, shin, | ¼ lb. | 1½ " | Cabbage, | 2 oz. | ¼ " |
| Fresh cod, | ½ " | 4 " | Sugar, | 5½ " | 3½ " |
| Oatmeal, | ⅛ " | ½ " | | | |
| Bread, | ½ " | 3 " | Total, for 3 men, | | 46¼ " |
| Butter, | 1 oz. | 2 " | " " 1 man, | | 15 " |
| Potatoes, | 1 lb. | 1 " | | | |
| Boston crackers, | 2 oz. | 1¼ " | No. 24, for 3 men. | | |
| Milk, 1-2 pint, | ½ lb. | 1½ " | | | |
| Cornmeal, | " " | " " | Round steak, | ½ lb. | 9 " |
| | | | Beef, shin (soup), | ¼ " | 1½ " |
| Total, | | 16¼ " | Fat pork, | 1 oz. | 1 " |
| | | | Fresh cod, | ½ lb. | 4 " |
| | | | Cheese, | 1 oz. | 1 " |
| | | | Milk, | 1 lb. | 3½ " |
| | | | Beans, | ⅓ " | 5 " |
| | | | Peas, | ⅓ " | 2⅓ " |
| No. 21. | | | Wheat bread, | 1½ " | 7½ " |
| | | | Rye bread, | ½ " | 2 " |
| Beef, neck, | ½ lb. | 4½ " | Boston crackers, | 2 oz. | 1¼ " |
| Milk, | " " | 2 " | Oatmeal, | " " | ⅓ " |
| Cheese, | 1 oz. | 1 " | Cornmeal, | 5–6 lbs. | 2⅙ " |
| Bread, | 1 lb. | 5 " | Potatoes, | 2½ " | 2½ " |
| Potatoes, | 2 " | 2 " | Turnips, | ⅓ " | ½ " |
| Sugar, | 1½ oz. | 1 " | Butter, | 3 oz. | 6 " |
| | | | Sugar, | 3½ " | 2¼ " |
| Total, | | 15½ " | | | |
| | | | Total, for 3 men, | | 53½ " |
| | | | " " 1 man, | | 18 " |

*D. Daily rations costing from 20 to 45 cents.*

| Food Materials. | | | Food Materials. | | |
|---|---|---|---|---|---|
| Kinds. | Amounts. | Costs. | Kinds. | Amounts. | Costs. |
| No. 25, for 4 men. | | | Potatoes, | ¼ lb. | ¼ cts. |
| | | | Cauliflower, | " " | 6 " |
| Round steak, | ½ lb. | 9 cts. | Rice, | ¼ " | 3 " |
| Beef, shin (soup), | ¼ " | 1½ " | Oyster crackers, | ½ " | 5 " |
| Beef, neck, | " " | 2 " | Sugar, | ¼ " | 2½ " |
| Fresh cod, | 1 " | 8 " | Butter, | 1 oz. | 2 " |
| Salt cod, | ⅓ " | 1⅔ " | | | |
| Pork, | ½ oz. | ½ " | Total | ——— | 29¾ " |
| Beans, | ½ lb. | 5 " | | | |
| Wheat bread, | 1½ " | 8 " | | | |
| Rye bread, | 1 " | 4 " | No. 29. | | |
| Boston crackers, | 2 oz. | 1¼ " | | | |
| Soda crackers, | 1 " | ¾ " | Mutton, leg, | ¼ lb. | 4 cts. |
| Oatmeal, | 1 lb. | 5 " | Oysters, | ½ " | 10 " |
| Cornmeal, | ¾ " | 2¾ " | Pease, | ⅛ " | 1½ " |
| Rice, | 2 oz. | 1⅛ " | Potatoes, | 1 " | 1 " |
| Potatoes, | 5½ lbs. | 5½ " | Oatmeal, | ¼ " | 1 " |
| Cabbage, | 2 oz. | ¼ " | Rice, | ⅓ " | 2½ " |
| Turnips, | " " | ⅛ " | Bread, | ½ " | 3 " |
| Carrots, | " " | ⅛ " | Oyster crackers, | ¼ " | 3 " |
| Butter, | 3 " | 6 " | Butter, | 1½ oz. | 3 " |
| Milk, | 2½ lbs. | 7½ " | | | |
| Sugar, | 3½ oz. | 2⅓ " | Total | ——— | 28¾ " |
| Total for 4 men, | ——— | 71⅝ " | No. 30. | | |
| " " 1 man, | | 18 " | | | |
| | | | Turkey, | ½ lb. | 18 cts. |
| No. 26. | | | Fresh pork, | 2 oz. | 1⅝ " |
| | | | Hominy, | ½ lb. | 2 " |
| Beef (soup), | ¾ lb. | 6 cts. | Potatoes, | 1 " | 1 " |
| Potatoes, | 1 " | 1 " | Beans, | ½ " | 1½ " |
| Bread, | ½ " | 3 " | Rye bread, | ½ " | 3 " |
| Cabbage, | 2 oz. | ½ " | Milk, | 1 " | 3½ " |
| Turnips, | 2 " | ⅛ " | | | |
| Carrots, | 2 " | ⅛ " | Total | ——— | 30⅜ " |
| Oatmeal, | 2 " | ⅜ " | | | |
| Milk, | 1 lb. | 3½ " | No. 31. | | |
| Rice, | 2 oz. | 1⅛ " | | | |
| Sugar, | 2 " | 1¼ " | Beef, sirloin, | ¼ lb. | 5 cts. |
| Corn meal, | ¼ lb. | ¾ " | Potatoes, | ½ " | 3 " |
| Soda crackers, | ¼ " | ¾ " | Bread, | 1 " | 6 " |
| Butter, | 1 oz. | 2 " | Butter, | 1 oz. | 2 " |
| | | | Sugar, | ½ lb. | 2½ " |
| Total | ——— | 20½ " | Beans, | ¼ " | 2½ " |
| | | | Skimmed milk, | 1 " | 2 " |
| No. 27. | | | Oysters | ½ " | 20 " |
| | | | Total | ——— | 43 " |
| Shad, | ¼ lb. | 4 cts. | | | |
| Eggs, | ¼ " | 4 " | No. 32. | | |
| Oatmeal, | 2 oz. | ⅝ " | | | |
| Rice, | 2 " | 1½ " | Salmon, | ¼ lb. | 10 cts. |
| Beans, | ¼ lb. | 1½ " | Beef, sirloin, | ¼ " | 5 " |
| Bread, | ½ " | 3 " | Oysters, | ½ " | 10 " |
| Potatoes, | 1 lb. | 1 " | Dried beef, | 1 oz. | 1 " |
| Soda crackers, | ¼ " | 2½ " | Wheat bread, | ½ lb. | 3 " |
| Sugar, | 2 oz. | 1½ " | Oatmeal, | 2 oz. | ⅝ " |
| Butter, | 1 " | 2 " | Rice, | 2 " | 1½ " |
| | | | Potatoes, | ½ lb. | ½ " |
| Total | ——— | 21⅜ " | Sweet potatoes, | 1 " | 6 " |
| | | | Cabbage, | 2 oz. | ½ " |
| No. 28. | | | Turnips, | 2 " | ⅛ " |
| | | | Butter, | 2 " | 2 " |
| Beef, round, | ¼ lb. | 4½ cts. | Milk, | 1 lb. | 3½ " |
| Shad, | ¼ " | 4 " | Sugar, | 2 oz. | 1½ " |
| Pease, | ¼ " | 2½ " | Total | ——— | 45 " |

## PECUNIARY ECONOMY OF FOODS.

I have been permitted by Professor Atwater to incorporate the following statements and tables, which have been long in preparation by him, with my address. I do so with the more satisfaction since he has assured me that the time has come when the services of the economist and the statistician are much needed to sustain the work of the chemist and the physiologist.

E. A.

### A. COST OF PROTEIN.

A subject that has received but little attention in this country, though it has become a vital one in Europe, and is becoming so with us, is the cost of the nutritive material of our foods. The relative cheapness or dearness of different foods must be judged by comparing, not the prices per pound, but the costs of the actual nutrients. In making such comparisons, the cost may be assumed to fall, not upon the inedible portions and the water, but solely upon the three classes of nutrients, the protein, fats, and carbohydrates.

The relative physiological values of the nutrients in different foods depend upon (1) their digestibility and (2) their functions and the proportions in which they can replace each other in nutrition. An accurate physiological valuation is, in the present state of our knowledge, at least, impracticable. The pecuniary costs of the nutrients are, however, more nearly capable of approximation.

Various methods have been proposed for computing the relative pecuniary costs of the nutrients of foods, none of which, however, are entirely beyond criticism. The following, based upon German estimates of the relative costs of protein fats and carbohydrates, is perhaps as satisfactory as any. They are those of Prof. König.

From extended comparisons of the composition and market prices of the more important animal and vegetable food materials, such as meats, fish, flour, etc., those which serve for nourishment and not as luxuries and form the bulk of the food of the people, it has been estimated that a pound of protein costs, on the average, five times as much, and a pound of fats three times as much, as a pound of carbohydrates; that, in other words, these three classes

of nutrients stand related to each other, in respect to cost, in the following proportions:

*Assumed ratios of costs in staple foods*

| | |
|---|---|
| Protein, . . | 5 |
| Fats, . . | 3 |
| Carbohydrates, . | 1 |

Perhaps a study of foods and prices in our markets might lead to a different scale of valuations, but this will serve our present purpose.

Suppose a pound of beef to cost 25 cents, and to contain 25 per cent of inedible matters, bone, etc., 45 per cent of water, and 30 per cent of nutritive substance, upon which latter — the bone and water being assumed to be without nutritive value — the whole cost comes. The 30 per cent or $\frac{30}{100}$ pounds of nutritive substance thus costs 25 cents, or at the rate of $83\frac{1}{3}$ cents per pound. If now we leave out of account the minute quantities of carbohydrates and the mineral matters, the whole cost will fall upon the protein and fats. Assuming these to cost in the ratio of 5 : 3 and the amounts in the meat to be: protein 15 per cent, and fats $14\frac{1}{4}$ per cent, an easy computation will show the protein to cost 106 cents and a pound of fats 64 cents.

Of the different nutrients, protein is physiologically the most important as it is pecuniarily the most expensive. For these reasons the cost of protein in different food materials may be used as a means of comparing their relative cheapness or dearness, as is done in the following table. The figures represent the ordinary prices per pound and the corresponding costs of protein, in specimens of food materials obtained in New York and Middletown, Conn., markets. Though the number of specimens is too small for reliable averages, the figures, taken together, doubtless give a tolerably fair idea of the relative costliness of the nutrients in the different classes of foods. It will of course be understood that the computations make allowance for the costs of the other nutrients, the fats and the carbohydrates, though for the sake of brevity the latter are omitted from the table.

COMPARATIVE COST OF PROTEIN IN FOOD MATERIALS.

| FOOD MATERIALS. | At prices per pound. | Cost of protein per pound. | FOOD MATERIALS. | At prices per pound. | Cost of protein per pound. |
|---|---|---|---|---|---|
| | cts. | cts. | | cts. | cts. |
| Salmon. | 100 | 511 | Salt mackerel. | 12.5 | 53 |
| Oysters, 50 cts. per quart. | 25 | 336 | Smoked ham. | 18 | 51 |
| Oysters, 40 " " " | 20 | 269 | | | |
| Oysters, 30 " " " | 15 | 202 | Smoked ham. | 15 | 43 |
| Lobsters. | 12 | 202 | Salt cod. | 7 | 43 |
| Eggs, 40 cts. per doz. | 28 | 157 | Mackerel. | 5 | 40 |
| Salmon. | 30 | 153 | Wheat bread. | 8 | 38 |
| Flounder. | 8 | 149 | Rice. | 9 | 38 |
| Beef, sirloin. | 25 | 06 | Cheese, whole milk. | 18 | 37 |
| Eggs, 25 cts. per doz. | 18 | 101 | Salt cod. | 6 | 37 |
| Shad. | 12 | 99 | Corned beef, lean. | 10 | 36 |
| Bluefish. | 10 | 98 | Beef, flank.[3] | 15 | 36 |
| Lake trout. | 15 | 92 | Beef, neck. | 8 | 33 |
| Mutton, leg. | 22 | 91 | Pork very fat,[3] salted. | 16 | 33 |
| Beef, sirloin. | 20 | 86 | Salt cod. | 5 | 31 |
| Halibut. | 15 | 85 | Potatoes,[3] $1.00 per bu. | 1.7 | 30 |
| Haddock. | 7 | 84 | Wheat bread. | 6 | 29 |
| Mutton, leg. | 20 | 82 | Cheese, whole milk. | 13 | 27 |
| Mackerel. | 10 | 79 | Alewives. | 3 | 27 |
| Cod. | 8 | 75 | Pork, very fat,[3] salted. | 12 | 25 |
| Mutton, side. | 20 | 73 | Smoked herring. | 6 | 24 |
| Beef, round. | 18 | 70 | Potatoes,[3] 75 cts. per bu. | 1.38 | 22 |
| Canned salmon. | 20 | 70 | Wheat bread. | 4 | 19 |
| Mutton, leg. | 16 | 66 | Beans, 13 cts. per quart. | 6.5 | 18 |
| Shad. | 8 | 66 | Cheese, skimmed milk. | 8 | 18 |
| Corned beef, lean. | 18 | 66 | Wheat flour. | 4.5 | 17 |
| Eggs, 15 cts. per doz. | 11 | 62 | Wheat flour. | 4 | 15 |
| Milk, 8 cts. per quart. | 4 | 61 | Oatmeal. | 5 | 15 |
| Beef, round. | 15 | 59 | Beans, 10 cts. per quart. | 5 | 14 |
| Cod. | 6 | 56 | Potatoes,[3] 50 cts. per bu. | 0.85 | 14 |
| Corned beef, lean. | 15 | 55 | Wheat flour. | 3.5 | 13 |
| Milk, 7 cts. per quart. | 3.5 | 53 | Corn meal. | 3 | 12 |

[3]Containing very little protein, the chief value being in the other ingredients.

Thus the nutrients of vegetable foods are, in general, much less costly than in animal foods. The animal foods have, however, the advantage of containing a larger proportion of protein and fats, and the protein, at least, in more digestible forms.

Among the animal foods, those which rank as delicacies are the costliest. By the above calculations, the protein in the oysters costs from two to three dollars, and, in salmon, rises to over five dollars per pound. In beef, mutton, and ham, it varies from 106 to 43 cents; in shad, blue-fish, haddock and halibut, the range is about the same; while in cod and mackerel, fresh and salted, it varies from 75 to as low as 31 cents per pound. Salt cod and salt mackerel are nearly always, fresh cod and mackerel often, and even the choicer fish, as blue-fish and shad, when abundant, cheaper sources of protein than any but the inferior kinds of meat. Among meats, pork is the cheapest; but salt pork or bacon has the disadvantage of containing very little protein.

It is well worth the noting that oat meal is one of the cheapest foods that we have; that is, it furnishes more nutritive material, in proportion to the cost, than almost any other. Corn meal is indeed cheaper, but the oat meal has this great advantage over corn meal and wheat flour, that it has more protein. Of course, if we are to eat large quantities of lean meat—and most of us, I think, eat more than is best for our health, saying nothing of our purses, the extra protein in the oat meal is of little consequence to us. But if one wishes to economize in his food, oat meal—rightly cooked—affords an excellent material therefor.

One of the most interesting things brought out in the table is cheapness of the staple vegetable food materials, such as potatoes, wheat flour, corn meal, oat meal and beans.

### B. AMOUNTS OF NUTRIENTS OBTAINED FOR TWENTY-FIVE CENTS IN DIFFERENT FOOD MATERIALS.

The above method of computing the relative expensiveness of different kinds of food materials is, as I have said, open to the objection that it is based upon a certain assumed ratio of relative costs of protein, fats, and carbohydrates, which may or may not be right in any given case. A method free from these objections consists in computing how much of the several nutrients may be obtained for a given sum, for instance, twenty-five cents, in different food materials. This is done in the following table.

AMOUNTS OF NUTRIENTS FURNISHED FOR TWENTY-FIVE CENTS IN FOOD MATERIALS AT ORDINARY PRICES.

| FOOD MATERIALS. | At prices per pound. | 25 CENTS WILL PAY FOR:— | | | | |
|---|---|---|---|---|---|---|
| | | Total food materials. | NUTRIENTS, POUNDS. | | | |
| | | | Totals. | Protein | Fats. | Carbohydrates. |
| | cts. | lbs. | | | | |
| Salmon. | 100 | .25 | .06 | .04 | .02 | — |
| Oysters, 50 cts. per quart. | 25 | 1.00 | .12 | .06 | .02 | .04 |
| Oysters, 35 cts. per quart. | 17.5 | 1.42 | .17 | .09 | .02 | .06 |
| Salmon. | 30 | .83 | 19 | .12 | .07 | — |
| Bluefish. | 10 | 2.50 | .27 | .25 | .02 | — |
| Beef, sirloin. | 25 | 1.00 | .29 | .15 | .14 | — |
| Shad. | 12 | 2.08 | .29 | .19 | .10 | — |
| Cod. | 08 | 3.13 | .34 | .33 | .01 | — |
| Mutton, leg. | 22 | 1.14 | .34 | .17 | .17 | — |
| Mackerel. | 10 | 2.50 | .35 | .25 | .10 | — |
| Beef, sirloin. | 20 | 1.25 | .37 | .19 | .18 | — |
| Mutton, leg. | 20 | 1.25 | .38 | .19 | .19 | — |
| Beef, round. | 18 | 1.39 | .40 | .29 | .11 | — |
| Canned salmon. | 20 | 1.25 | .44 | .25 | .19 | — |
| Shad. | 08 | 3.13 | .44 | .29 | .15 | — |
| Cod. | 06 | 4.17 | .45 | .44 | .01 | — |
| Mutton, side. | 20 | 1.25 | .46 | .17 | .29 | — |
| Beef, round. | 15 | 1.67 | .49 | .35 | .14 | — |
| Salt cod. | 07 | 3.57 | .58 | .57 | .01 | — |
| Salt mackerel. | 12.5 | 2.00 | .60 | .30 | .30 | — |
| Mackerel. | 05 | 5.00 | .71 | .51 | .20 | — |
| Butter. | 30 | .83 | .73 | — | .73 | — |
| Milk, 8cts. per quart. | 04 | 6.25 | .74 | .21 | .23 | .30 |
| Salt cod. | 05 | 5.00 | .82 | .80 | .02 | — |
| Milk, 7cts. per quart. | 03.5 | 7.14 | .84 | .24 | .26 | .34 |
| Cheese, whole milk. | 18 | 1.39 | .90 | .38 | .49 | .03 |
| Beef, neck, whole. | 08 | 3.13 | .92 | .48 | .44 | — |
| Cheese, whole milk. | 15 | 1.67 | 1.08 | .45 | .59 | .04 |
| Smoked herring. | 06 | 4.17 | 1.21 | .84 | .37 | — |
| Pork, salted, fat. | .16 | 1.56 | 1.23 | .04 | 1.19 | — |
| Pork, salted, fat. | 12 | 2.08 | 1.65 | .06 | 1.59 | — |
| Cheese, skim milk. | .08 | 3.13 | 1.69 | 1.20 | .21 | .28 |
| Wheat bread. | .08 | 3.13 | 2.08 | .28 | .06 | 1.74 |
| Wheat bread. | 06 | 4.17 | 2.75 | .37 | .07 | 2.31 |
| Potatoes, $1.00 per. bushel. | 01.7 | 3.24 | 3.04 | .27 | .03 | 2.74 |
| Beans, 10 cts. per. quart. | 05 | 5.00 | 3.96 | 1.16 | .11 | 2.69 |
| Potatoes, 75 cts. per bushel. | 01.25 | 18.00 | 4.13 | .36 | .04 | 3.73 |
| Wheat bread. | 04 | 6.25 | 4.15 | .56 | .12 | 3.47 |
| Oatmeal. | 05 | 5.00 | 4.48 | .76 | .36 | 3.36 |
| Wheat flour. | 04.5 | 5.55 | 4.83 | .62 | .06 | 4.15 |
| Wheat flour. | 04 | 6.25 | 5.44 | .69 | .04 | 4.71 |
| Potatoes, 50cts. per bushel. | 00.85 | 26.47 | 6.06 | .53 | .05 | 5.48 |
| Indian meal. | 03 | 8.33 | 6.90 | .70 | .29 | 5.91 |

The methods of computing the cost of protein and the amounts obtained for twenty-five cents in different foods are as follows.

1. *Cost of protein.*—Suppose we wish to learn the costs of the nutrients in wheat flour, containing 11.1 per cent of protein, 1.1 per cent of fat, and 75.4 per cent of carbohydrates, and costing four cents a pound.

Let $x$ represent the cost of a pound of carbohydrates in cents. Then, by the ratio of costs assumed above, a pound of fats would cost $3x$ cents and a pound of protein $5x$ cents. 100 pounds of the flour will cost 400 cents and will contain 11.1 pounds of protein, 1.1 pounds of fats, and 75.4 pounds of carbohydrates. We shall have

$75.4x$ cts. = cost of 75.4 pounds of carbohydrates.
$3.3x$ " = " " 1.1 " " fats.
$55.5x$ " = " " 11.1 " " protein.

Total $134.2x$ " = " " 100 " " flour = 400 cents.

Whence $x = 3$ cts. cost of carbohydrates per lb.
$3x = 9$ " " " fats per lb.
$5x = 15$ " " " protein per lb.

2. *Amounts of nutrients obtained for 25 cents.*— At 4 cents per pound for the flour, 25 cents will pay for 6.25 pounds. By the percentage composition above given 6.25 pounds of flour will contain .69 pound of protein, .07 pound of fats and 4.71 pounds of carbohydrates which are the amounts of nutrients obtained for 25 cents.

## CONCLUSIONS.

The facts to which I have referred and others, which this is not the place to dwell upon in detail, seem to me to warrant the following statements.

1. The subject is one of the utmost importance. If, as you say, for the large majority of people, "half the struggle of life is a struggle for food,"— and I believe that your own statistics as well as those of Colonel Wright for this country, and those of Dr. Engel for Germany show that the statement is none too strong,— it is certainly worth while that people should know of what their food consists and how to economize it.

2. In order that ordinary people may know these things, it is necessary first of all that the facts should be found out. Here, as in many other arts and economies of life, the practical details which are at once most important and seemingly the most simple, rest upon data so extended and laws so abstruse as to be found out only by the longest inquiry and most profound research. It is only lately that science has begun to bring the most useful results, and hence we are just at the beginning of our knowledge of

these matters, yet enough has been done to give us a great deal of extremely useful information, and to show us where and how we must search for more.

3. Economy of food must be regarded from two standpoints :— (1) physiological and (2) pecuniary.

Viewed from the physiological standpoint, the facts at hand make it reasonably certain that many people in our country, including not simply the wealthy but those in what we call moderate circumstances as well, consume much more food than their bodies demand, and that the excess is detrimental, not only to their purses but, what is worse, to their health. The chief error seems to be in the excessive use of meat and other animal foods, though I am inclined to think that sweetmeats are also consumed to a very detrimental excess. The poor, too, whom poverty debars from overeating suffer, not only because of insufficient food, but because the food they do have is not that which is best adapted to their wants.

Viewed from the pecuniary standpoint, the data at hand indicate a great deal of bad economy, in the purchase of excess of food. This manifests itself in two ways: one is consumption of unnecessarily large quantities of food to which I have just referred. Of the many ways in which American wastefulness manifests itself, one of the chief, I believe, is in the waste of food. It is indeed better that part of the excess we purchase should be thrown away, than that it should all be employed in overloading our stomachs, but it would be better to purchase only so much as we need and use that rightly. And it is not the well-to-do only, but people in moderate circumstances, mechanics, farmers, tradesmen, professional men with limited incomes, among whom this wastefulness is very common.

The other kind of bad economy is in the use of needlessly expensive foods. Among that large class of people whose incomes are moderate, and intelligence and desire to economize considerable, a great deal is lost in the purchase of materials which supply the needed nutritious materials at high cost instead of those which would furnish them in equally wholesome and nutritious forms for less. Many a thrifty house pays from half a dollar to a dollar and a half a pound for the protein of the food on her table when she might obtain it in equally nutritious and wholesome forms for from twelve to forty cents.

But what seems to me the most pathetic part of the whole problem is, that it is the needy who know least how to make good use of what they have. It is too often the poor man's money that is wasted in the market and it is the food of the destitute that loses most from improper preparation. Here it is especially true that "to him that hath shall be given and from him that hath not shall be taken even that which he hath."

4. It is as important that the information should be spread as that it should be gained. There is a great dearth of reliable literature on this subject. This is due mainly to its newness. It is only within a few years that the data have accumulated of such amount and reliability that the authors of standard works have felt like incorporating them in their treatises. The army of ordidinary writers, therefore, have never had the facts before them. The text books have had but little to say upon the subject, while the magazines and newspapers have contained a great deal that might better have been left unwritten. But treatises are already appearing in foreign languages, and must soon be written in English.

I think that the literature of the subject needs three things.

First: standard treatises giving the results of investigations to date.

Second: smaller works with the main results epitomized in form convenient for those especially interested in the matter to read.

Third: tracts for the people in which the most useful practical facts shall be set forth in plain and simple language illustrated by diagrams and enforced by practical applications which ordinary people may comprehend and use.

And finally, let me repeat, for this, I believe, is the most important thing of all for us to consider now,—we need more research. Almost nothing has been done on this side of the Atlantic. Nearly all the analyses we have of American food-materials except cereal grains and milk have been made within a short time in a single chemical laboratory. The most valuable part of our information comes from Germany. But, although the laws of nutrition are the same there as here, they are at best but imperfectly investigated. The pressing need is for more knowledge. The most successful research, that of the highest type, must be carried on here, as in Europe, in connection with the higher educational institutions.

But such research is costly and our universities and colleges have not the means for prosecuting it. Science in this country depends mainly upon private munificence for its advancement. The cost of a single pleasure yacht, if devoted to research in this direction, would not only give the donor fame, but would bring tenfold return in the benefits it would confer.

W. O. A.

## APPENDIX.

The following data will in some measure justify the statements which I have given in my address, both in regard to the gain of the people of the United States in realized wealth, but also in respect to the increase of products which make for the common welfare.

Statistics of realized wealth, when given in terms of money, are delusive and uncertain, and such aggregates are of little value; but there are certain standards which may be taken as indications of the progress of accumulation or of the increased quantities of merchandise on the way from producer to consumer.

The data of insurance against loss by fire are capable of very accurate compilation from the official statements which are required by law.

One of the most valuable compilations of this sort appeared in the Insurance Monitor of New York, for September 1884, made by the editor C. C. Hine, Esq.

The progressive increase in the amount of insurance against loss by fire since 1865—the figures indicating millions of dollars—is as follows:—

| | | | |
|---|---|---|---|
| 1865 | $ 2564 | 1875 | $ 6039 |
| 1866 | 2945 | 1876 | 5914 |
| 1867 | 3165 | 1877 | 6008 |
| 1868 | 3420 | 1878 | 6229 |
| 1869 | 3778 | 1879 | 6673 |
| 1870 | 4035 | 1880 | 7184 |
| 1871 | 3987 | 1881 | 7949 |
| 1872 | 4529 | 1882 | 8534 |
| 1873 | 5783 | 1883 | 9359 |
| 1874 | 5889 | | |

The grain crop of 1865, including maize, wheat, oats, rye, barley and buckwheat amounted to 1,127,499,187 bushels; the crop of 1884 numbered 2,981,920, 332 bushels; the crop of 1885, in which the excess of corn will make up for the deficiency of wheat, will probably exceed 3,000,000,000 bushels. Except for the consolidation and extension of the railway service, and the very great reduction in the freight charge, these crops could not have been moved.

The number of miles of railroad Jan. 1, 1865, was 33,908; Jan. 1, 1885, it was 125,379. One-half the tonnage carried by these railways consists of food for man or beast.

If we compare the average charge per ton, per mile, as it was in 1865–1869, inclusive, with the average charge of each subsequent year, the difference on the traffic of each subsequent year assessed on the tonnage of that year amounts to a sum more than equal to the money expended on all the new railroads of that year.

The average product of pig iron for 1865–66–67 was 1,247,850 net tons; for 1882–83–84, a fraction, only, under 5,000,000 net tons each year.

The cotton crop of 1865–66, 1866–67, 1867–68 averaged 2,600,000 bales each year. The crops of 1882–83, 1883–84, 1884–85 averaged 6,122,000 bales each year. The present crop may exceed 7,000,000 bales.

The last 20 crops of slave-grown cotton numbered 56,757,906 bales. The last 20 crops of free-grown cotton numbered 86,829,795 bales; a gain of 30,031,889 bales, or 1,500,000 bales per year, besides an increase in the average weight per bale of about ten per cent; 400 lbs. in 1841, 485 lbs. in 1885. This difference, with the value of the seed now saved, but formerly wasted, may be computed at a value of about $1,800,000,000.

The debt of the United States at its maximum in 1865 amounted to $2,997,386,203, according to the estimate of Sec'y McCulloch, who added to the recorded debt, the sum due and in arrears for the pay of the army and on war contracts. On the 1st of August, 1885 the net debt amounted to $1,386,555,527.

Our population in 1865 was about 35,000,000; it is now over 57,000,000. The debt per capita in 1865 was over $84. It is now less than $24.

The debt of all Europe in 1884 as reported by M. G. Mulhall at

the meeting of the British Association in Montreal was $21,319,-620,000. Omitting Russia, Turkey, Servia and the bankrupt states of Spain and Portugal, there remains over $15,000,000,000 of debt due by England, Germany, France and other states which are assumed to be solvent. The population of these latter states is now about 200,000,000 and the proportion of their steadily increasing debt is $75 per head. These states have one mile of railroad to each 2420 persons. In the United States there is one mile to each 450 persons.

The number of men in actual service in the standing armies of Europe, omitting Russia and Turkey, as listed in Martius' Year Book for 1884 was 2,675,386 or one in every twenty-one and a half of the adult men, assuming one in four of the population as such.

The number in the army and navy of the United States is 36,871 or one in three hundred and eighty-five.

The number of men in the reserves in Europe, who are enrolled and subject to active service at a moment's notice, is far greater than the number actually under arms. If to the waste of time of those who are under arms be added the cost of their support, at least ten per cent of the productive power of Europe is spent in passive war even in periods of so-called peace while a large part of the remaining product is distributed according to privilege rather than according to service. These conditions are as impossible of continuance as they are dangerous in their existence.

I may safely leave you to make the application of these facts to the relative conditions of this country and of Europe—in sadness rather than in exultation.

At the beginning of the next century this country will be free from debt—our army will have become a mere national police—the progress of invention will have rendered navies powerless either for offence or defence.

We are to be tried by the fire of prosperity and tested by the dangers of luxury. The burning question now is, Are we capable of maintaining a just government in its integrity?

"Of what avail, the plough or sail,
Or land, or life, if freedom fail!"

E. A.